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THE GENERIC AND SPECIFIC STATUS OF FOUR OHIO SPIDERS OF THE GENUS AGELENOPSIS

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INTRODUCTION

Every taxonomist sooner or later faces a situation in which he must determine whether he is dealing with a single highly variable species, or with several species which appears to intergrade. This problem confronting us has been recognized by Petrunkevitch, Emerton, Comstock, Chamberlin, Ivie, Gertsch and others.

Arachnologists have been perplexed by the variability of a species which has been considered *Agelena naevia* Walckenaer as the following quotations will indicate.

Petrunkevitch (1925) on page 561 states: "It does not require prolonged study to show that variation in size in *Agelena naevia* is very great. Specimens collected in the same locality, often under the same piece of loose bark, guarding their cocoons with eggs, and therefore in the same stage of maturity, are occasionally twice the size of others. The fact that two such distinguished arachnologists as Graf Keyserling and Becker have described two new species of Agelena from North America, which long since have been recognized as synonyms of *A. naevia*, shows that the variation in structure is also sufficient to be considered as specific in absence of intergradient forms."

Emerton (1890) recognized the great variation that exists in both the palpus of the male and epigynum of the female. He has illustrated four types of palps and seven variations in the atrial opening of the epigynum. He says that, "The shape of the external opening of the epigynum is even more variable than that of the palpal organ."

Comstock (1912), page 586, in his spider book: "This species is either a variable one in the form of the palpi of the males and

in the form of the epigynum of the female or more than one species have been confused under this name."

Chamberlin and Ivie recognize several species of this complex, four of which occur in the state of Ohio, namely: *Agelena naevia* Walckenaer, *Agelena americana* Keyserling, *Agelena utahana* Chamberlin and Ivie, and *Agelenopsis emertoni* Chamberlin and Ivie. These men (Chamberlin and Ivie) (1935) suggest that: "This species, with a number of others, has been consistently synonymised with *Agelena naevia* Walck. by later authors." They here were referring to another form (*Agelena potteri* Blackwell) which is referred to later in this paper.

PURPOSE OF PAPER AND ACKNOWLEDGMENT

This paper is an attempt to determine, from a detailed study of the epigyna and palps of a large number of specimens, the true status of the four forms of this genus found in Ohio.

This research was conducted in the Department of Zoology, The Ohio State University. The author wishes to acknowledge his indebtedness to Dr. W. M. Barrows, of the Department of Zoology and Entomology, for the advice and criticism given during the course of this study.

MATERIALS AND METHODS

Material for this problem was collected during the summers of 1937 and 1938. Most of the material was preserved in 95% alcohol. A few specimens were killed, in the field, in Petrunkevitch's fixing fluid. The fluid used was his second formula which keeps indefinitely and which can be used an unlimited length of time without harmful effects to the tissue. It does keep the tissue soft and in good condition. The formula, as Petrunkevitch (1933) gives it, is:

60% alcohol	100 cc.
Nitric Acid, c. p., sp. gr. 1.42	3 cc.
Ether	5 cc.
Cupric nitrate, c. p., crystals	2 grams.
Paranitrophenol, c. p., crystals	5 grams.

In the laboratory, the specimens were first separated as to sex. All of the specimens used were mature and therefore the males with their well developed palpal copulatory organs were easily distinguished from the females, which possess the epigynum.

All males were further separated into four groups on the basis of differences in appearance of several structures of the mature palp. For further study the right palp of ten specimens of each group was taken from the spider and preserved in cedar wood oil. It was found that cedar wood oil; firstly, cleared the specimen to a great degree thus

giving greater definition to its parts, secondly, its viscosity being greater than alcohol it aided in suspending the specimen at almost any angle desired for observation and thirdly, the specimens could be observed for long periods of time when using strong light without evaporation or movement due to evaporation currents.

The epigyna of the females, also, were observed to be of four types. From a large number of specimens, twenty-five of each type were selected without regard to size of the spider. The epigyna of these twenty-five females of each group were lifted from the venter of the abdomen, after breaking the chitin covering the copulatory sacs, with dissecting needles. They then were cleaned of excess fatty tissue and placed in individual vials, with the spider from which they were taken, for future study.

Some of the specimens of each type, which had been killed in Petrunkevitch's fixing fluid, were used for more detailed study. The epigyna of these were taken from the specimens in the same manner as the others, then washed in 70% alcohol and prepared for sectioning. The technique followed in the preparation of this material was worked out by Wynkoop (1939). He used diaphanol as a softener of the chitin rather than potassium hydroxide. This latter substance proved harmful to the minute tubules as well as to the softer parts of the epigynum. Diaphanol removes those substances in chitin which usually prohibits sectioning. In his technique, Wynkoop suggested subjecting the material to diaphanol from 70% alcohol. The time required for diaphanol to remove the undesired materials from the chitin depended on the density of the chitin. The smaller and softer epigyna required twenty-four hours while the larger and older specimens required as long as four days to turn milky white, which is the indication that the softening process is completed. When the material was ready for sectioning it was taken from the diaphanol and washed thoroughly in 70% alcohol, dehydrated and embedded, following the usual procedure of paraffin sectioning. The sections were cut eight microns in thickness. They were mounted serially and stained with aneline blue on the slides. It was found that an overstaining of the sections brought out the minute orifices and slight differences apparent in the chitin of the various structures. Camera lucida drawings were made of these serials, then in some instances the drawings were mounted on cardboard. These sectional drawings which were mounted on cardboard made exact models of the epigynum when cut out and put together, for detailed study.

RESULTS

Upon examination of the specimens in the collection it was found that both males and females could be separated into four distinct groups on characters presented by the mature palp of the males, and, by the epigynum of the females.

DESCRIPTION OF THE MALE PALPS

The palp contains the copulatory apparatus on the ventral surface of the terminal segment. Only the cymbium can be seen in a dorsal

view. It usually is covered with the same thin chitin, yellowish in color, as the other segments of the pedipalps. The basal portion of the cymbium is hemispherical but the distal end is comparatively long and narrowly tapered. The entire surface of the cymbium is sparsely covered with short hairs and contains from three to six spines, irregularly placed. This structure is similar in all the four groups. From the ventral view the main parts of the copulatory apparatus can be observed. Hidden from view, in a specimen which has not been especially dissected or treated, are various structures embedded in an excavation in the base of the cymbium. These structures are common to all types and therefore are not of importance in this study.

The two structures which differ in each group are the conductor (Pl. III, a) and the tip of the embolus (Pl. III, b). The embolus is a long, evenly coiled tube of one and a quarter to one and a half turns in length which usually does not extend much beyond the boundary of the cymbium. It has its origin near the center of the enlarged part of the cymbium. The swing of the coil is from the point of origin first ectal, then posterior, medial and anterior. The tip lies either in this anterior sector, or the posterior of the second loop, depending upon the length of the embolus and the tightness of its coil. The last quarter of its length shows that the embolus is a tube formed by a roll of the chitin with the outer edge overlapping as much as half the circumference of the tube thus formed. In some forms the roll is not complete at the tip, resulting in a trough instead of a tube.

The conductor is a hard and black chitinous projection, pointing forward and situated on the ectal side of the palp. It has its origin at the same level as, and ectal to, the origin of the embolus. Its length and shape varies in the different forms. The chitin is usually rough and, especially in the older specimens, is broken or splintered along the edges.

In comparing the differences in these two structures of the palp of these four groups; the length, thickness, and the end portion of the embolus, and the shape and size of the conductor are significant. The specific name of the spider possessing the type of palp being described will be used to distinguish it.

The longest, most uniform embolus is to be found in *naevia* (Pl. III, *naevia*, b). The hard portion of the chitin is shiny black with a series of fine ridges running the length of the coil. The portion of the roll which overlaps is of thin, almost transparent chitin. This overlap is toward the inside of the coil of the embolus. The coil of the embolus completes a full one and one half turns with the tip lying near the center of the circle formed by the complete revolution. Near the end the embolus tapers considerably and also bends back (dorsally) slightly toward the main body of the palp. The tip is plain, without a notch or protuberance and the roll remains wound to the tip. The conductor is very regular in this form (Pl. III, *naevia*, a). It is comparatively long and narrow with longitudinal ridges extending its entire length. The conductor is concave in cross-section with the cavity facing the palp. The anterior end is pointed, the point being formed by the ventral edge being longer than the dorsal.

The coil and appearance of the embolus of *emertoni* (Pl. III, *emertoni*, b) are essentially the same as in the preceding form. But the tip of the embolus is very distinctive for this type. The overlapping edge of the chitin breaks away from the roll in the last quarter turn and forms a gutter which widens toward the tip, with the tube portion forming its inside margin. At the tip the tight complete roll can be seen partially encompassed in the loose flap. The tip edge contains a heavy, black knob of chitin which gives it a forked appearance under low magnification. The conductor (Pl. III, *emertoni*, a) is very similar to the same structure of *naevia* except that it is not quite as long and pointed.

In *utahana* the embolus (Pl. III, *utahana*, b) is similar to *naevia* but is not quite as long. It is perfectly plain, except for a slight thickening of the chitin at the end, and continues the regular swing of the coil. The roll remains closed as a tube throughout the entire length of the embolus. The conductor (Pl. III, *utahana*, a) of this type is distinctive. It is very wide at the base, and has very little transverse curvature, when compared with the two forms already described. The anterior end is blunt with a thick chitinous knob at the outside, anterior edge.

These two diagnostic structures of the form *americana* show a great departure from the normal plan expressed in the other forms. Both structures are heavier in construction. The embolus is shorter and the conductor larger in size when compared with the others.

The embolus (Pl. III, *americana*, b) is short, thick and tightly wound. It completes only one revolution with just the tip extending over the origin. The roll of the embolus opens, before the complete revolution is made, into a deep trough, with the concave surface exposed anteriorly. The ventral edge of the trough has a distinct projection the apex of which protrudes forward beyond the regular curvature of the embolus. The distal side of this projection meets the dorsal edge of the trough at the tip.

The large and bulky conductor (Pl. III, *americana*, a) of this form is not hidden by the embolus. In cross-section it is almost a complete circle, with the open portion facing the main body of the palp. On the posterior end of the conductor is a hard black chitinous knob. The anterior edge is rough and the ventral corner possesses a protruding tip.

DESCRIPTION OF THE EPIGYNA

The epigynum, as found in the females of the four forms of this genus, may be divided into three units. It has a single cavity or atrium (Pls. I, II, h) which opens to the outside on the ventral surface. This atrium is common to the two large structures, the copulatory sacs (Pls. I, II, a), which extend anteriorly from each side of it. These two units are independent of each other and contain identical structures. The epigynum is therefore bilaterally symmetrical. Each of these two units is really a single, coiled and much-twisted tube in which appear definite structures differing in size, shape, color and position. The names given to the parts of the epigynum in this paper are the same as those suggested by Petrunkevitch (1925). They are the atrium, vulva, copulatory sac, diverticle, seminal receptacle, connecting tube, fertilization tube and the blind canals of the copulatory sacs and receptacles.

The only portion of the epigynum to be seen in an undissected spider is the atrium (Pls. I, II, h). It is the only external opening of the epigynum and is located on the anterior margin of the epigastric groove on the ventral side of the abdomen. The general shape of the cavity (atrium) is that of an ellipsoid with the long axis parallel to the epigastric groove. The chitin at the external edge of this invagination is heavier and darker than that of the surrounding exoskeleton, forming a ridge, hereafter called the vulva (Pls. I, II, g). The posterior edge of this chitinous ridge is the thickest and contains a depression in its vertical surface which faces the epigastric groove, in some species quite prominent and in others almost lacking. This depression (Pls. I, II, i) is usually wider inside than at the surface of its lateral extremities which gives it the semblance of a lateral pouch on each side.

The shape of this hard chitinous rim, or vulva, which surrounds the atrium differs for each of the four groups studied. The anterior edge may be without obstructions, that is, it is smooth and without a projection as in *americana* (Pl. I, Fig. 3), or may possess notches or a prominent lip. *Naevia* (Pl. I, Fig. 1, g) presents this other extreme. The anterior edge of this form possesses a pronounced lip in the center which extends over the atrium slightly more than half the short axis of the ellipse. The width of the lip is from one-half to one-third of the total width, or long axis of the atrium. This lip is slightly notched in the center of its margin. The anterior portions of the vulva of the two remaining types (*utahana* and *emertoni*) (Pl. II, Figs. 5, 7, g) are quite similar. Instead of either of the two extremes mentioned, their anterior margins possess two notches equally spaced, one on each side of the median line. The notches of *emertoni* are usually less pronounced. The atria differ in these two species in that *utahana* is wider in proportion to the width than is the other.

The shape of the pouch in the posterior margin of the rim of the vulva in *emertoni*, *naevia* and *americana* (Pls. I, II, Figs. 1, 3, 7, i) is very similar. It varies in specimens of the same group but in all three of these forms this depression takes in better than two-thirds of the posterior margin of the vulva. The epigynum of *utahana* (Pl. II, Fig. 5, i) stands in contrast with the others concerning this pouch in that it is almost as wide in its dorsal-ventral measurement as in its lateral extensions. The concavities at the lateral extremities are not prominent and are sometimes lacking.

The copulatory sacs proceed anteriorly from each side of the common atrium in all these forms. These sacs are of very thin, almost transparent chitin. They may be simple, undivided structures or may give the appearance of having a second lobe in which the anterior portion is bent back on the main stem leading from the atrium. These reverted portions occupy the space between the two lateral or main stems of each side with their extremities dorsal to the seminal receptacles.

The copulatory sacs of *americana* (Pl. I, Figs. 3, 4, a) are of the simple type, that is, they are single sacs arising from the lateral surface of the atrium and do not fold on themselves at the anterior edge. *Utahana* (Pl. II, Figs. 5, 6, a) shows a slight reversion of the sac while the two remaining forms, *naevia* and *emertoni* (Pls. I, II, Figs. 1, 2, 7, 8, a) are

long and fluted. In the latter two forms the sacs extend forward from the common atrium and then turn back on themselves with the folded portion toward the middle of the epigynum. Further, although the sacs in all these species are transparent, *naevia* and *emertoni* with *utahana* to a slight degree, appear to be wrinkled or plicated. These plications usually are darker than the sac proper in color.

The sacs end in a diverticle which can be distinguished from the sac proper in that it is heavier and more smooth although it is usually of the same light colored chitin. It is in the form of a wide band or roll in some and in others it is flat and covers most of the ventral surface of the copulatory sac to which it attaches. These diverticles end as blind tubes of small diameter on the dorsal surface between the copulatory sacs. The diverticle of *americana* (Pl. I, Fig. 3, c) is very large, covering most of the ventral surface of the sac and is made of comparatively thick, light colored chitin. In *naevia* (Pl. I, Fig. 1, c) it is tubular and connects with the lower part of the reverted portion of the sac. It then continues as a loop toward the ectal edge of the sac then bends anteriorly and finally ends in the blind tube on the median line of the epigynum with its end dorsal to the other structures and pointing backwards. *Emertoni* (Pl. II, Fig. 7, c) presents the longest diverticle. It is tubular and attaches to the end of the reverted portion of the sac, then extends anteriorly in an arc to the median line of the epigynum and ends as a short blind tube similar to *naevia*. The diverticle of *utahana* (Pl. II, Fig. 5, c) is short and simple. It is less distinguishable from the sac than in the other forms and tapers quickly as it extends dorsally along the medial edge, forming the blind tube.

On the ventral surface of each of the copulatory sacs lies a seminal receptacle. These two receptacles are located just anterior to the atrium. In some specimens the receptacles are so close together that their chitinous walls appear to be fused and in others they are quite separate. The cavities of the receptacles which have their walls fused are never connected.

There is so much variation in the shape and position of the receptacles in specimens of a single group that a description of them as found in a single specimen of any one group would not give a true picture (Pls. I, II, Figs. 1, 2, 3, 4, 5, 6, 7, 8, e). In general, it may be stated that in all forms studied the receptacles are easily recognized as the bodies composed of dark and very thick chitin which rest on the ventral surface of the copulatory sacs. Internally they possess a single cavity which may or may not be constricted in the center. Each of these areas, set apart by the constriction, is a continuation of the lumen of the tube which enters the receptacle at that point, one, of the tube connecting the receptacle with the diverticle and the other of the fertilization tube.

Each seminal receptacle is connected to the diverticle of the copulatory sac on which it rests by a single tube. In some this tube is long and narrow and composed of the same hard dark chitin as the receptacle while in others it is so short that the receptacle appears to be connected directly with the copulatory sac. The connecting tubes of *naevia* and *americana* (Pl. I, Figs. 1, 3, d) arise from the medial edge of

the copulatory sacs along with, and as a part of the diverticle and enter the receptacles along the dorsal surface, the lumen of the tube entering the cavity of the receptacle at a very sharp angle. In *emertoni* and *utahana* (Pl. II, Figs. 5, 7, d) these tubes arise from the lateral portion of the diverticles and progress across the ventral surface of the copulatory sacs. In *utahana* the tube enters the receptacle in the middle of the anterior surface whereas the tube in *emertoni* enters the receptacle in much the same manner and position as in the first two.

In all these forms there is a very prominent coiled tube (Pls. I, II, Figs. 1, 2, 3, 4, 5, 7, 8, f) leading from the lateral surface of each receptacle and extending almost to the posterior edge of the epigynum. This tube is small and dark in color. In tracing its path, it leaves the lateral edge of the receptacle and swings posteriorly over the ventral surface of the copulatory sac. Continuing posteriorly it then makes one and one-half turns around the neck of the sac and terminates on the dorsal surface of the atrium. The end of the tube (Pls. I, II, Figs. 2, 4, 6, 8, k), which is open, rests midway between the lateral edge and the mid-line of the epigynum. The lumen is small but well defined and extends the entire length of the tube without variation. This tube is called the fertilization tube since it apparently transports the sperm from the receptacle to the uterus which lies just inside the epigastric groove. Since the position of this tube is nearly constant for these four groups no detailed description for each species needs to be given.

The blind tube (Pls. I, II, Figs. 2, 4, 6, 8, j) of the receptacle is short and of the same hard and dark chitin as this body. It arises from the anterior dorsal surface and extends back along the receptacle. In most specimens of all four species the blind tubes of the diverticles end close to the end of these tubes from the receptacles.

DISCUSSION

The genus Agelena was erected, supposedly by Walckenaer, in 1805. But the type form is given in the literature as *A. labyrinthica* (Clerck). Apparently Walckenaer put the genus, to which the species was assigned by Clerck, in synonymy. The form was recognized by others since the following citation is given in Walckenaer's Tableau des Araneides (page 51):

"1. Ag. labirinthe (Ag. labirinthica). Pl. 6, Fig. 55 et 56. Fabr., Linn., Walck., Faun. Paris, t. 2, p. 217, n.° 60. Schaeff., Icon., Pl. 19, Fig. 8. Albin, Pl. 17, Fig. 83. Clerck, p. 79, Pl. 2, tab. 8. Lister, tit. 18, Fig. 18, p. 60.

"2. Ag. marquée (Ag. naevia). Bosc, Manuscript sur les araignées la Caroline, Pl. 1, Fig. 2."

In his description in this work, Walckenaer says that the eyes are eight in number and nearly equal between themselves. The only figure given is of the eye pattern. This shows two strongly recurved rows, the anterior medians of which are much smaller than the rest, they being of equal size. The name of Ag. marquée (*Ag. naevia*) and the reference to Bosc's manuscript are the only mention of this form in this early work.

In the second volume of Walckenaer's Histoire Naturelle des Insectes Aptères he describes the genus Agelena again and gives a very meager

description of *naevia*. Although the date on the front page of the book is given as 1837 this work apparently did not appear until July of 1841, according to the footnote on page 473 by White (1841), "July 2. Since this paper was written the 2nd volume of Walckenaer's work has been published." The first published description of *naevia* appears in Walckenaer's second volume. The description is not original with him. He obtained manuscripts from two people who collected spiders in America and then he described the species from their descriptions and figures. In the preface to volume one of the Histoire Naturelle des Insectes Aptères he mentions that Bosc presented him with a manuscript, accompanied by drawings of twenty-five spiders from Carolina. The manuscript was given to him while writing his Tableau des Araneides and only the names of these forms were included. The other manuscript he obtained was written by Thomas Abbot, containing 535 Araneids and Phalangids from Georgia. These drawings were accompanied by a notebook written in English and entitled "Notes and Observations on the Drawings of the Spiders of Georgia." In his description of *naevia*, Walckenaer gives the notes, and not the drawings, of these two manuscripts. The following incomplete description is given by him:

"Abdomen ovale-allongé, fauve, avec deux linges brunes longitudinales, parallèles sur le milièu du bos, et deux bandes brunes sur les côtés, droites dans la femelle, ou qui sont légèrement festoonées dans le mâle. Corselet d'un jaune orange, avec deux bands brunes longitudinales, qui alleignent jusqu'aux yeux. Pattes d'un fauve jaunâtre, annelées de noir aux articulations."

Since the time of Walckenaer, arachnologists have added many species to this genus. It remained for Giebel (1869) to suggest a new genus for the American forms since they differed distinctly from the type form of the genus (*A. labyrinthica*). Many authors state that these new forms have been synonymized with *naevia*, or are variations of that form. The characters given by Walckenaer are of a very general nature and are of the sort which are subject to great variation and overlapping within the four species studied in this paper. Many modern workers with spiders now consider the figure of the palp of the mature male and the epigynum of the female as the most reliable characters necessary to delimit a species. The figures of the palps of *emertoni*, *utahana* and *americana* and the epigyna of *utahana* and *americana* are given with the original descriptions. No figures were given for *naevia* in the first descriptions and where they have occurred in later works they have been called a variety of *naevia*. It is probable, therefore, that the figures given in this study are the first given for this form as a distinct species.

Petrunkevitch (1925) recognized (p. 561) "the great dissimilarity between the external reproductive system of *A. naevia* and that of the closely allied European species, *A. labyrinthica*." The outstanding differences he noted are (p. 568): "The first and most important difference between this species and *A. naevia* is in the position of the organ. Instead of being directed forward, it is directed backward, so that the copulatory pouch and receptacle come to lie between the copulatory opening and the genital groove." Further he noted the "absence of a

common atrium and the consequent separation of the reproductive system into two independent units."

The genus Agelenopsis was erected by Giebel (1869) with the type form *A. albipilis*. He set apart this genus from Agelena on the position and size relationship in the eyes. In his new genus he suggests that the eyes are arranged in three rows; two in the first row, four in a straight line in the second and two again in the third row. The anterior laterals are the largest of the eyes. He found them to be different in Agelena. "Auffällig genug von Agelena verschieden, wo die Stirnaugen erheblich kleiner, die zweite Reihe eine Bogenlinie bildet und die hintern Augen weiter aus einander gerückt sind."

Other authors have noted the differences between the American form and the European agelenas. Although he does not recognize the genus Agelenopsis, Simon (1898) describes the eyes of the genus Agelena as being nearly homogeneous, arranged in two sharply recurved rows. The four median eyes form a quadrangle with the sides almost parallel. Also he states, "dans la plupart des cas, les yeux médian antérieurs sont un peu plus gros que les latéraux et que les médians postérieurs." In a text figure, to which he here refers, of the eye pattern of *labyrinthica*, the anterior medians are much larger than the others. He also noted that the patella of the palp in the males of American species was without a point whereas the European forms have an apophysis of one shape or another on the anterior-external surface. In his figure of the patella and tibia of *labyrinthica* he shows a long pointed apophysis on the tibia which extends forward over the tarsus. We do find that the tibia of the palp in the American complex shows a slight rounded projection but it is not as exaggerated as the type shown in his figure.

Cambridge (1897–1905) recognized the genus Agelenopsis although the figures of his Central American forms do not agree in structures of the palp of the males and the epigynum of the females, with the North American forms of this genus. He does say that the spiders of the genus erected by Giebel "differ from Agelena (type *A. labyrinthica*) chiefly in the relative proportion of the anterior eyes, the laterals being much larger than the centrals, whereas in Agelena they are subequal."

Chamberlin and Gertsch (1929) noted that some forms of the genus Agelena had the apical joint of the hind spinnerets shorter than the penultimate and had a prominent, excavated region on the outer side of the tibia of the male palp with two or more conspicuous processes. For these forms Chamberlin erected the sub-genus (Hololena) of Agelena. On the other hand, the members of the genus Agelena (sens. str.) "form a group in which the hind spinnerets have the apical joint much longer than the penultimate, and in which the tibia of the palpus of the male has a single extension on the outer side."

Chamberlin and Ivie (1935) accept the genus Agelenopsis. They describe four new species of this genus in their work. *A. emertoni*, one of the four described by them, is one of the species used in the study of variations of the copulatory apparatus in this paper. The other three forms studied here were originally described as belonging to the genus Agelena. These authors state, however, that the type form (*A. albipilis*) used by Giebel, is a synonym of *A. potteri* Blackwell.

Blackwell (1846) described this species, taken in Canada in the vicinity of Toronto, as belonging to the genus Agelena. It is interesting to note that Blackwell says: "the eyes of the anterior row are larger than those of the posterior row, the intermediate ones being the largest of the eight." This condition is contrary to the findings of Giebel. In observations on the eye pattern of specimens of each group of this series, the author noted that the size relationship of the eyes varies enough so that in some the anterior medians are slightly larger than the laterals of the same row, and in others all four of the anterior row appear to be equal. Since the eyes are mounted on the front and top of the head, with those of the anterior row directed forward and those of the posterior—the medians directed upwards—the laterals to the sides, not all eyes can be seen in full view from any one angle, and their size relationship cannot be easily determined.

The form described by Blackwell (*potteri*) can be accepted as belonging to the genus Agelenopsis, since his description of the palp of the male is in accord with the description of this appendage of the American forms as given by Simon. Blackwell says:

"The cubital and radial joints of the palpi are short; the former is not provided with an apophysis, but the latter has a large, obtuse one at its anterior extremity, on the outer side; the digital joint is oval, but elongated, the extremity being slender and compact; it is convex and hairy externally, concave within, comprising the palpal organs, which are highly developed, complicated in structure with a large, spiral spine, brownish black on the outer and pale yellow on the inner side, which is very prominent and recurved at its extremity, and a strong, dark reddish brown process at the outer side projecting beyond the margin of the digital joint."

The rest of his description is of a general nature, but the description of the end of the embolus of the palp "which is very prominent and recurved at its extremity," and of the conductor "a strong, dark reddish brown process at the outer side projecting beyond the margin of the digital joint," are definitely diagnostic characters for the male of this species. He does not mention the epigynum of the female.

Keyserling (1877) described a new species (*A. americana*) of the genus Agelena from North America, from two specimens given him by Dr. L. Koch. He did not know in what part of the country they were taken since it was not mentioned by the collector. Besides giving a rather complete and detailed description of the color, markings, shape of the body and legs he mentions that the patella of the male palp is short and rounded on top and that the tibia bears a short protuberance which is thick and slightly curved at the tip. This is the typical condition of these segments of the palps of members of this complex.

His description is accompanied by two side views of the palp and one ventral view of the epigynum. He describes the cymbium of the palp as a cover which is somewhat broad and strongly curved and drawn out into a somewhat long, thin beak in front. Also, the embolus which is medium thick becomes thinner and hollow toward the end. He describes the conductor as a flat process, hollow below which is outside the embolus and extends forward. It ends in a small curved

tip. According to him the epigynum is a cross-oval pit at the rear part of a low rise. The figures of both the palps and the epigynum given by him are distinct for this form.

Americana has been recognized as a synonym of *A. pennsylvanica* C. Koch by several arachnologists. C. Koch (1843) gives a very meager description of his species and figures a colored dorsal view of the female. He does not mention the epigynum of the female and all characters used are of such a general nature that they could be used for several of the species recognized in this present study. The spelling *pensylvanica*, as it appears in the original description, apparently is a typographical error since it is spelled *pennsylvanica* on his plate. The male of this form was not known to C. Koch. Keyserling gives this comment at the end of his description of *americana*:

"Ob die von C. Koch beschriebene (*Ag. pensylvanica*$_2$) mit meiner identisch ist, von der sie in der Färbung abweicht, lässt sich unmöglich feststellen, da C. Koch nichts über die Gestalt der Epigyne in seiner Beschreibung sagt."

The ($_2$), after the name, refers to a footnote giving the reference to C. Koch's description.

SUMMARY OF THE STATUS OF THE GENUS

The females in this collection fell into four distinct groups on the basis of just one characteristic—the shape of the vulva of the epigynum. The internal structures of these epigyna were distinctly different for each of the four types. One has to note only the shape and position of the copulatory sacs and the diverticles of each type to see that these are characteristic for each species.

A degree of variation in the epigynum was to be noted in the twenty-five specimens of each species. In the first place the epigyna from a group of any one species are not the same size. Such measurements as the total length of the entire epigynum, the length and width of the vulva and the position and shape of the projections on the anterior lip, when present, were made for each group possessing them. The measurements showed that any one character may vary independently of the others. Although some of these measurements revealed considerable variation, none were great enough to cause any uncertainty as to the group in which they belong.

There also was no direct relationship between the size of the epigynum and the length of the spiders from which they were taken. Of the twenty-five specimens of *naevia* measured, the total length from the chelicerae to the spinnerets varied from 18 mm. to 13 mm. The other species showed similar variations in size. There was a tendency for the larger epigyna

to be found in the larger specimens but this was not always the case. It may be stated that the variation in the length of the specimen was greater than the variation found in the characters measured in the epigynum, and, that they did not coincide.

The table below gives the extremes for the measurements made in the twenty-five epigyna of each group. The numbers in parentheses represent the length of the spider, or spiders, in which these extremes were found. The measurement given for the length of the vulva equals the short axis of the ellipse while the width equals the long axis, except in *naevia* where the length equals the greatest distance from the anterior to posterior margins of the left side of the protruding lip or tongue, parallel to the length of the spider. The length of the lip in *naevia* is the distance it extends along the short axis. The epigynum of *americana* is without projections on the anterior margin of the vulva. The measurement given for the pouch in the posterior margin of the vulva indicates the width of the external edge of the depression and does not include the lateral pouches. All measurements are in millimeters.

Agelenopsis emertoni. Range of length of the spider, 12 mm. to 8 mm.

	Maximum	Minimum
Width of atrium	0.60 mm. (12)	0.39 mm. (8)
Length of atrium	0.27 mm. (9, 10, 11)	0.18 mm. (8)
Width of pouch	0.48 mm. (11, 12)	0.30 mm. (10)
Greatest length of epigynum	1.14 mm. (9, 12)	0.84 mm. (8)
Distance between points on anterior margin	0.33 mm. (12)	0.18 mm. (10, 8)

Agelenopsis naevia. Range of length of the spider, 15 mm. to 8 mm.

	Maximum	Minimum
Width of atrium	1.26 mm. (15, 17)	0.78 mm. (15)
Length of atrium	0.45 mm. (14, 17)	0.24 mm. (16)
Width of pouch	0.66 mm. (14, 15, 16, 17)	0.54 mm. (14,15,16,17,18)
Greatest length of epigynum	2.34 mm. (14)	1.74 mm. (14)
Length of lip	0.30 mm. (14, 15, 16)	0.18 mm. (13, 15, 17)

Agelenopsis americana. Range of length of the spider, 15 mm. to 8 mm.

	Maximum	Minimum
Width of atrium	0.72 mm. (13, 15)	0.42 mm. (9)
Length of atrium	0.42 mm. (10, 12, 14)	0.30 mm. (8, 10, 11)
Width of pouch	0.48 mm. (12, 14)	0.30 mm. (9, 10, 11)
Greatest length of epigynum	1.14 mm. (13, 15)	0.84 mm. (9)

Agelenopsis utahana. Range of length of the spider, 11 mm. to 6 mm.

	Maximum	Minimum
Width of atrium	0.54 mm. (10)	0.33 mm. (6)
Length of atrium	0.18 mm. (10, 11)	0.12 mm. (6, 7, 9, 10)
Width of pouch	0.18 mm. (9, 10, 11)	0.09 mm. (7, 10)
Greatest length of epigynum	1.11 mm. (6, 9)	0.84 mm. (7, 9, 10, 11)
Distance between points on anterior margin	0.27 mm. (10)	0.18 mm. (6, 7, 9)

Petrunkevitch (1925) suggested the epigynum of *Agelena naevia* to be quite variable and of two types, one larger and more complicated than the other. Of the four types described in this paper his two types probably present the greatest extremes in the series. His figures 1 and 2 of Plate I (page 573) are dorsal and ventral views of his small variety and are of *americana* while figures 3 and 4 of the same plate are of *naevia* of this series. They are not large and small types of the same species but two distinct species. He suggests that (page 571) "all parts of the male external reproductive organs are subject to considerable variation." Again, these structures may vary within limits in a species but the embolus and conductor of *naevia* are so different from those of *americana* that the two are easily separated. He does not figure the palp of *americana* but does give a lateral view of a palp with a long embolus which is *naevia* (text figure, page 569). The males of the two other forms used in this study (*emertoni* and *utahana*) also can be identified as separate species by the differences in these two structures.

Comstock (1912) does not figure the epigynum of an agelena in his spider book, but suggests that the epigynum of the female is quite variable as well as the palp of the male. He does figure two types of palps which he labels as variations of *naevia*. Neither of these figures (Figs. 665 and 666, page 587) is of the *naevia* suggested in this paper. In the revised edition of the Spider Book, Gertsch (1940) labels these same two figures *pennsylvanica* and *potteri*. The figure showing the long embolus, according to Comstock, is called *potteri* by Gertsch and the short form is labeled *pennsylvanica*. The *pennsylvanica* is the same as *americana* of this series while the other is the type form of the genus Agelenopsis (Giebel), called *albipilis* by him and found to be synonymous with *potteri* by later authors (Chamberlin and Ivie, 1935). *Potteri* was described by Blackwell in 1846 while *albipilis* did not appear until 1869. This species has not been taken by the author in the state of Ohio.

The eye patterns of the European form *Agelena labyrinthica* and of the American forms are different. The trochanters of the American forms are without a notch. The males of the American forms are without distinct apophyses on the tibia, but possess a long embolus and a distinctive conductor. The

epigyna of the American types differ markedly from *labyrinthica*, as figured by Petrunkevitch, as well as those figured by Cambridge. From these facts it is evident that these forms, each possessing definite characters, are different genera.

Since the study of a large number of specimens of the genus Agelenopsis showed that the individuals, both males and females, can be separated on the basis of a few structures—the condition of the embolus and conductor in the male, and the shape of the vulva in the females, into four groups, and that these characters are different and relatively constant for each group, it suggests that there are four distinct species in this complex.

It is obvious, therefore, from the material presented that we have been dealing with more than one species of spider.

CONCLUSIONS

1. The genus Agelenopsis, erected by Geibel, includes the American forms which differ from the genus Agelena representing the European species.

2. The specific name *A. americana* (Keyserling) is to be used in preference to *A. pennsylvanica* (C. Koch).

3. The epigynum of the female and the palp of the male are specific characters for these members of the genus Agelenopsis.

   a. The shape of the vulva of the epigynum is constant and distinctive for each species.

   b. The appearance of the conductor and embolus of the male palp is constant and distinctive for each species.

   c. While the length of the spider of a species is quite variable, the structures of the copulatory apparatus are fairly constant in size.

4. The descriptions of the epigyna of the two extreme variations of *naevia*, as given by Petrunkevitch, are correct.

5. These two variations, recognized by Petrunkevitch, are to be established as two distinct species, namely: *A. americana* and *A. naevia*.

6. There are four well founded species of the genus Agelenopsis occurring in the state of Ohio.

7. Descriptions and figures of the male palp and the epigynum of *Agelenopsis naevia* (Walckenaer) as a distinct species probably are given here for the first time.

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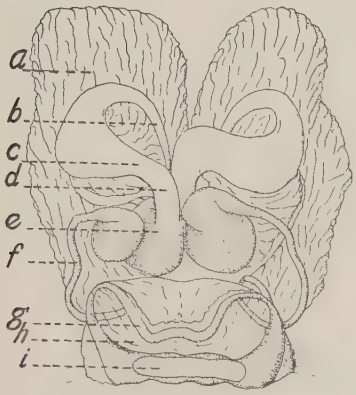


Fig. 1

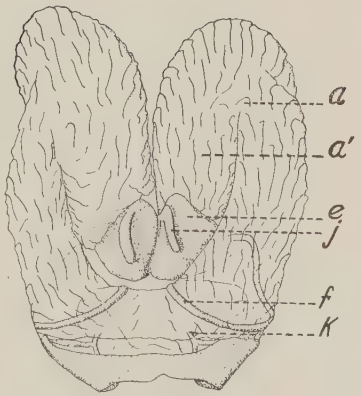


Fig. 2

A. naevia

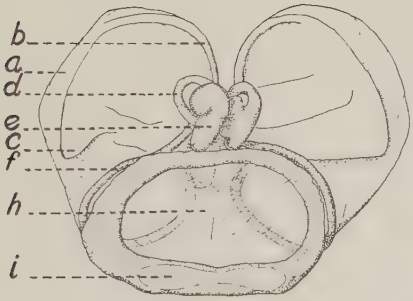


Fig. 3

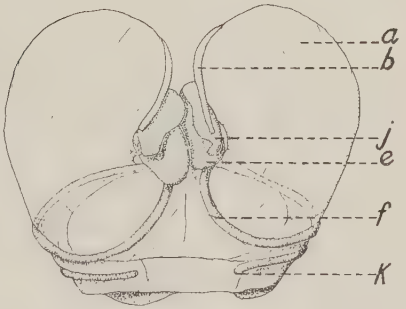


Fig. 4

A. americana

Fig. 1. Ventral view of dissected epigynum of *Agelenopsis naevia.*
Fig. 2. Dorsal view of same.
Fig. 3. Ventral view of dissected epigynum of *Agelenopsis americana.*
Fig. 4. Dorsal view of same.

(All epigyna and palps drawn to the same scale.)

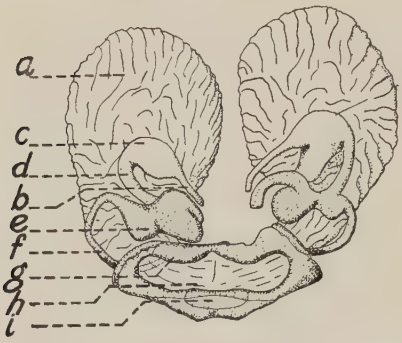


Fig. 5

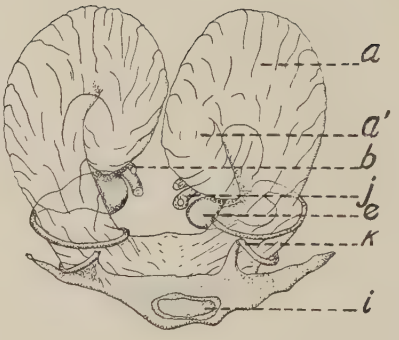


Fig. 6

A. utahana

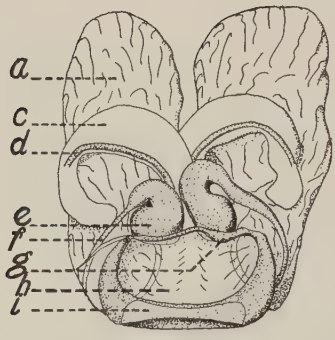


Fig. 7

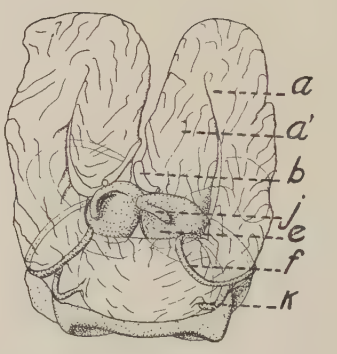


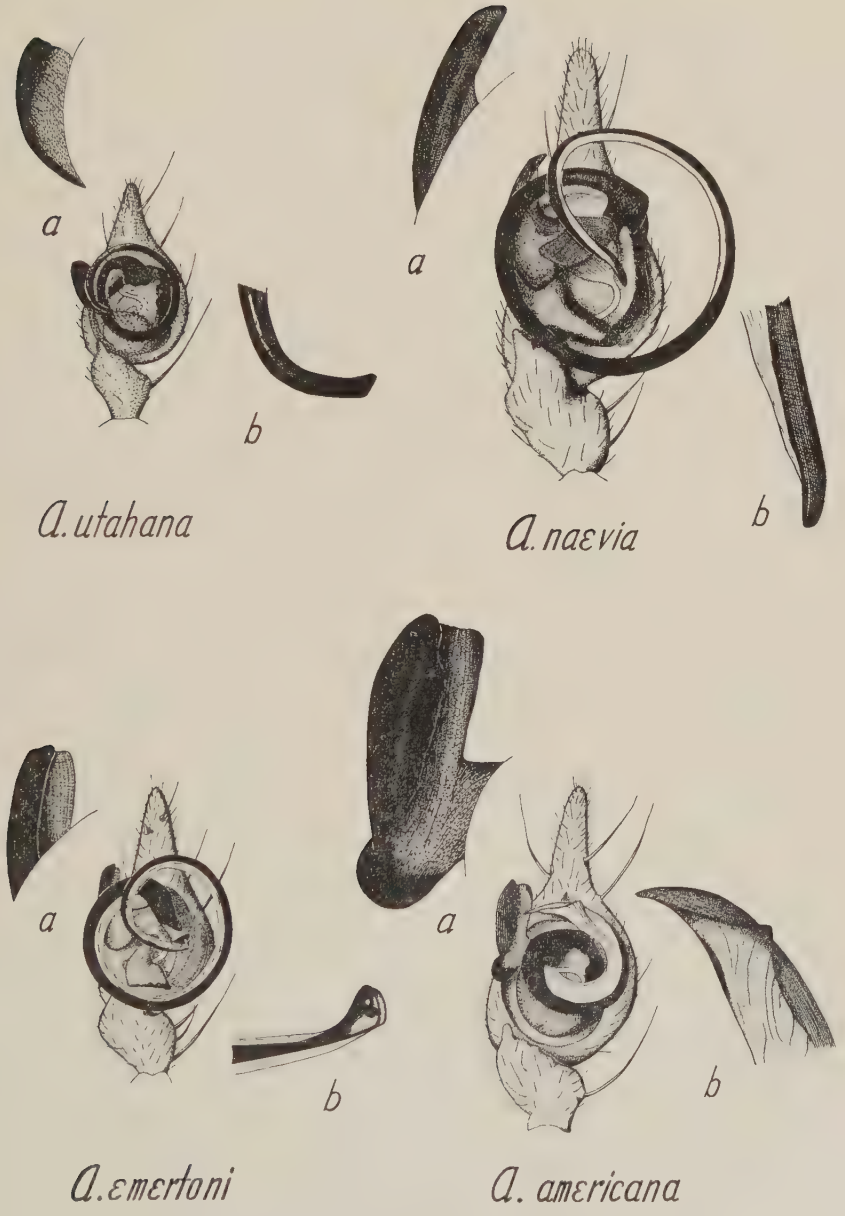
Fig. 8

A. emertoni

Fig. 5. Ventral view of dissected epigynum of *Agelenopsis utahana*.
Fig. 6. Dorsal view of same.
Fig. 7. Ventral view of dissected epigynum of *Agelenopsis emertoni*.
Fig. 8. Dorsal view of same.

The structures in the above figures are indicated by letters.

a. Copulatory sac.
a'. Reverted portion of copulatory sac.
b. Blind tube of the diverticle.
c. Diverticle.
d. Tube connecting the diverticle with the seminal receptacle.
e. Seminal receptacle.
f. Fertilization tube.
g. Projections on the anterior edge of the vulva.
h. Atrium.
i. Pouch in the posterior margin of the vulva.
j. Blind tube of seminal receptacle.
k. End of the fertilization tube.



Ventral views of the right palps of *A. utahana*, *A. naevia*, *A. emertoni* and *A. americana*.

a. Enlarged figures of the conductor.
b. Enlarged figures of the tip of the embolus.

THE SENSITIVITY OF ANEMOMETER CUPS

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INTRODUCTION

The question as to which type of anemometer cup should be universally accepted as the standard type cup has long been disputed by those interested in the question. At the present time the organizations interested in questions involving the use of anemometers employ varied types of anemometer cups on their instruments and frequently change to a different type in the hope of obtaining better results.

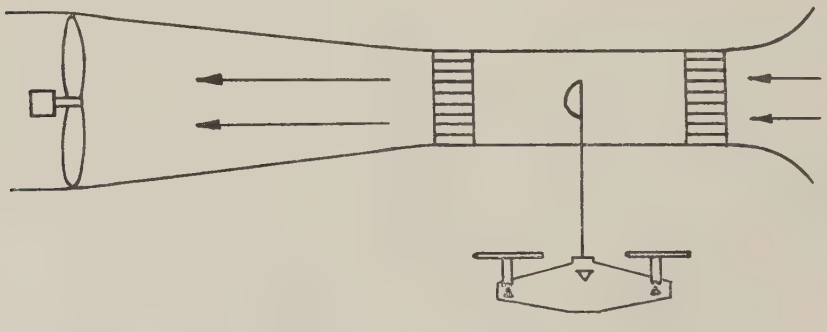

Fig. 1. Sketch of Wind Tunnel.

Studies have been made by various investigators as to the comparison of different type of cups best suited for their individual needs, but little has been done to compare the relative merits and disadvantages of various types of cups from comparable points of view.

It has been, therefore, the object of this investigation to study and determine the points of similarity and contrast of various cup shapes and to arrive at some conclusion as to the best cup shape or shapes which will give the maximum sensitivity in an anemometer.

APPARATUS

The apparatus used consisted of two parts, namely, a wind tunnel and the various cup shapes themselves. The wind tunnel used was of sufficient size to accommodate the cup shapes and was of such construction that accurate control of the wind velocity could be maintained. A sketch of the wind tunnel and the cup shape when in position is illustrated diagrammatically in Figure 1.

The wind velocity created inside of the tunnel was measured by a pitot tube pressure gauge which had previously been completely calibrated against a vane type anemometer. The force on the specimen was measured by means of an aerodynamic balance similar in construction to a laboratory platform balance.

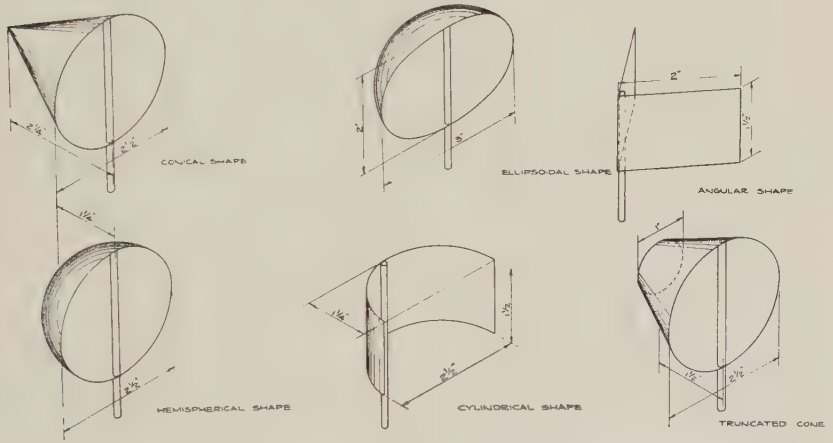

Fig. 2. Anemometer Cup Shapes.

The apparatus which was tested consisted of seventeen different cups comprising six general forms. The shapes tested were as follows: (1) angular shaped cups bent at angles of 15°, 30°, 45°, etc., ranging from 15° to the 180° straight angle; (2) truncated conical shape; (3) regular conical shape; (4) hemispherical shape; (5) ellipsoidal shape; and (6) cylindrical shaped cups. Diagrams of the various shapes with dimensions are shown in Figure 2. Each of the cup shapes was mounted on an arm and placed in position inside of the wind tunnel as indicated in Figure 1.

PROCEDURE

After the cup shapes had been mounted in position, the wind tunnel was turned on and data recorded of both the wind velocity and the corresponding force on the sample. Readings of the wind velocity were taken on the pressure gauge at appropriate steps from zero wind velocity to the capacity of the wind tunnel, which was 16.23 miles per hour velocity. The corresponding forces were measured on the aerodynamic balance.

The cups were completely tested in one direction and then turned around 180°, so that the other side of the cup faced the wind flow. Complete readings were again taken. The force against the cup and force with the cup mean the force produced when the wind blows against the interior of the cup and the force produced against the exterior of the cup respectively as illustrated in Figure 3.

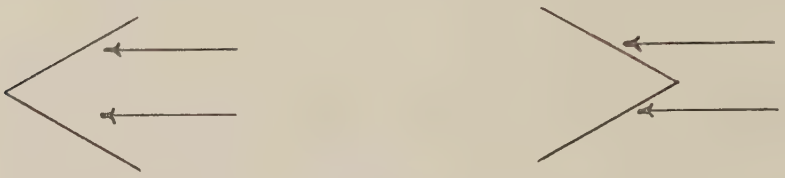

Fig. 3. Wind Forces against the cup (left) and with the cup (right).

Plots were then made to show the relationship between the force and the wind velocity in each case. Sample sets of curves are represented in Figures 4 to 8. In these graphs, the circular figures pertain to the values of the force against the cup, while the solid dots represent the values of the force with the cup.

RESULTS

On the basis of the results presented in the curves, it is possible to arrive at a conclusion as to the most sensitive cup tested. Following the line of reasoning that the force against the cup would be greater than the force with the cup at the same wind velocity in order for the cup system of an anemometer to rotate, it becomes evident that the cup which exhibits the greatest difference in force on the front and on the back of the cup (or force against and force with the cup respectively) for the same wind velocity would be the most sensitive cup.

TABLE I

Force Differences

Cup Shape	0–8 miles/hour	8–12 miles/hour	12–16 miles/hour
Ellipsoid	3.3	9.2	15.1
Cone	2.5	6.5	11.8
Hemisphere	2.4	7.7	14.9
105° Angle	3.2	6.5	8.4
90° Angle	2.9	6.0	11.3

For the purpose of comparison of the cups, the region for the wind velocity was divided into three parts, namely, that region representing 0 to 8 miles per hour velocity, that representing 8 to 12 miles per hour, and that representing 12 to 16 miles per hour velocity. The corresponding values for the differences in force were then recorded. Such data are presented in Table I.

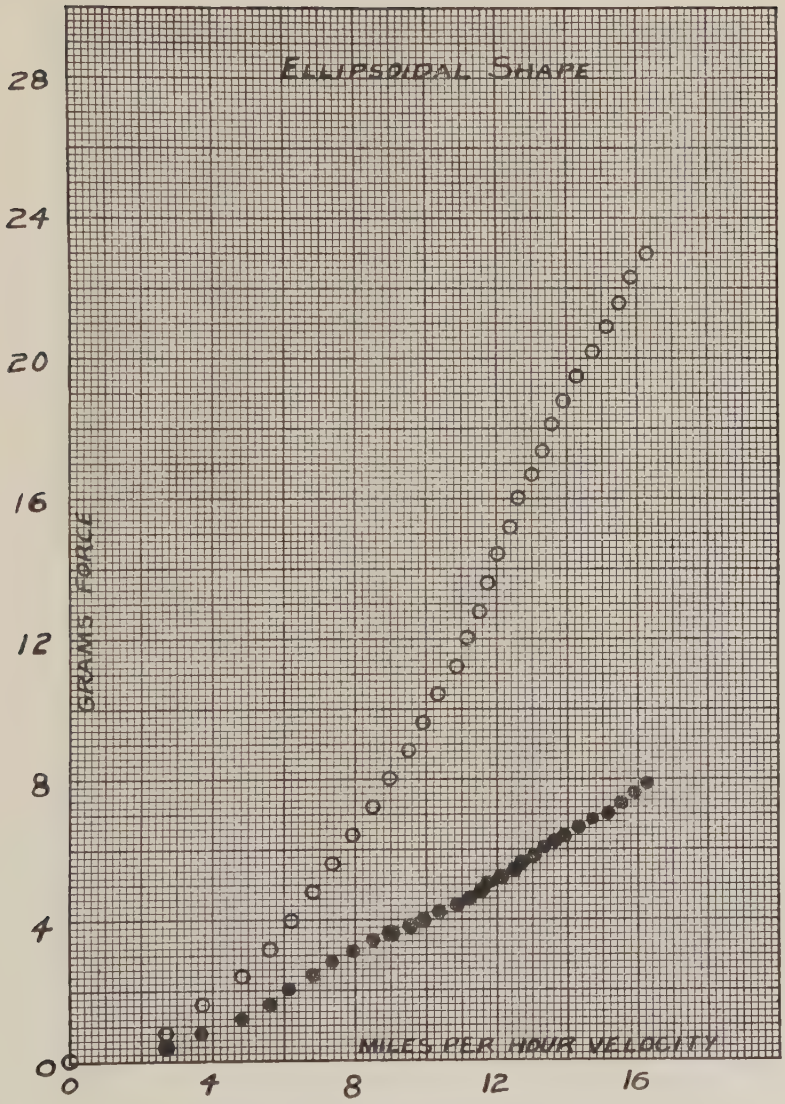

Fig. 4. Relation between force and wind velocity with ellipsoidal cup.

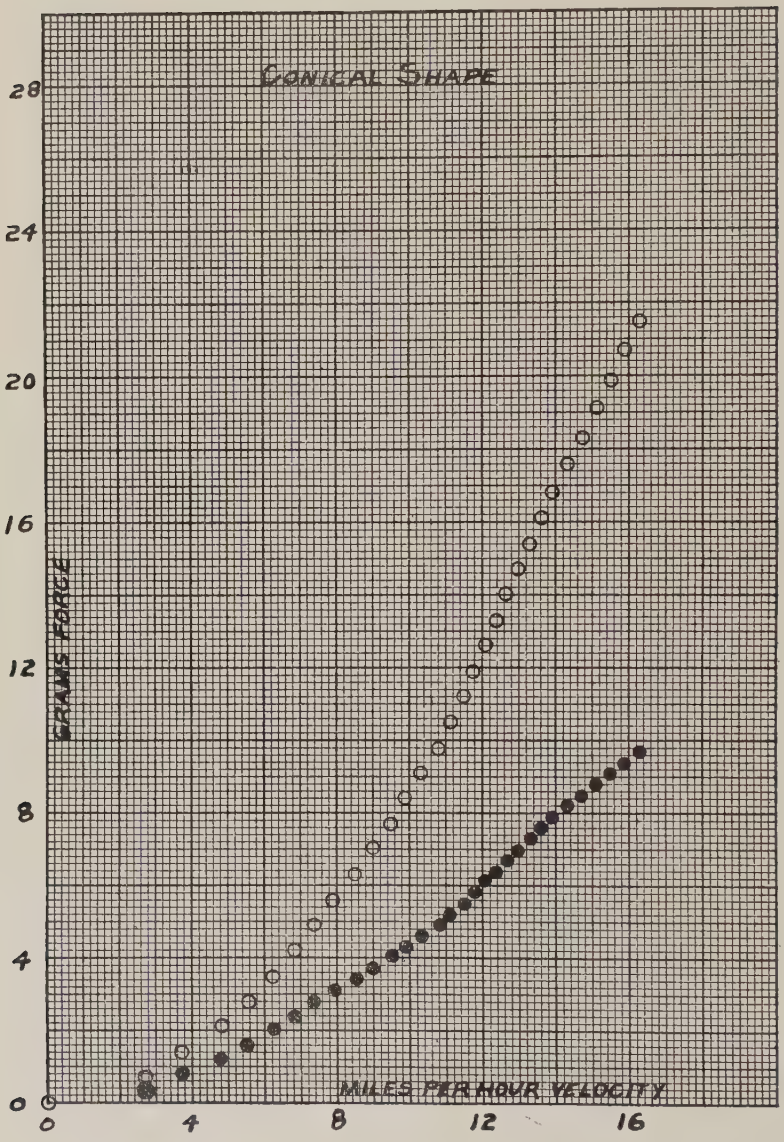

Fig. 5. Relation between force and wind velocity with conical cup.

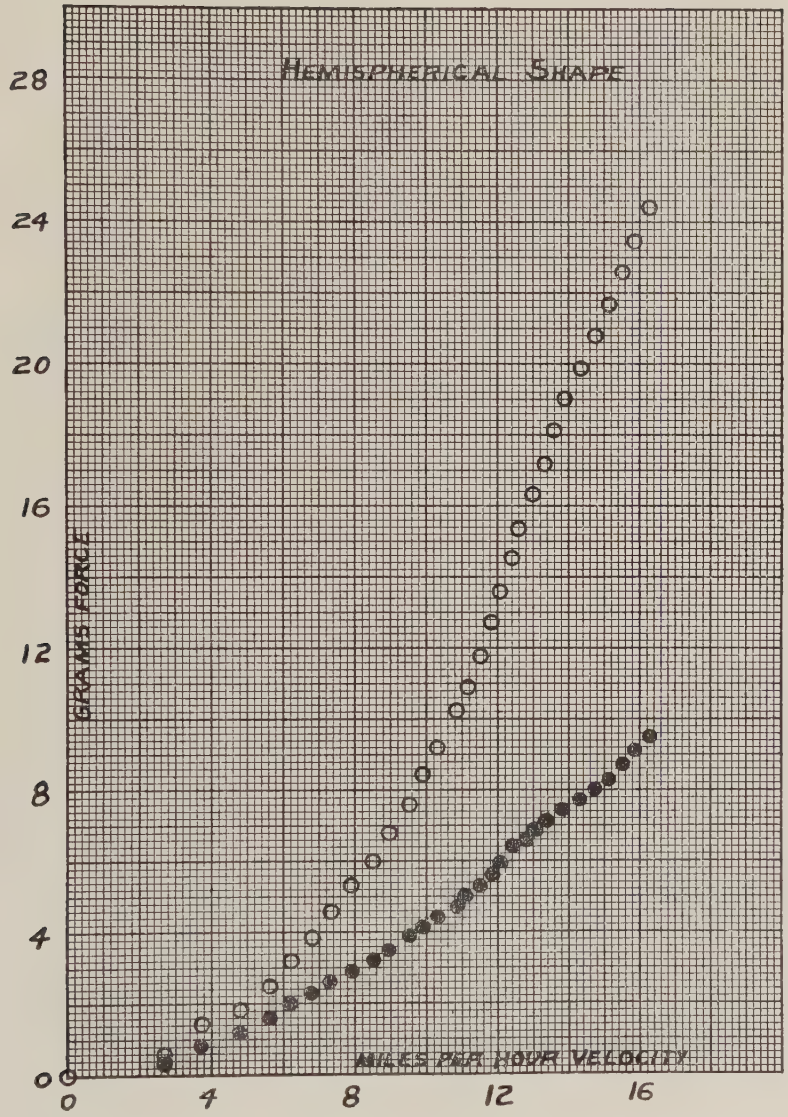

Fig. 6. Relation between force and wind velocity with hemispherical cup.

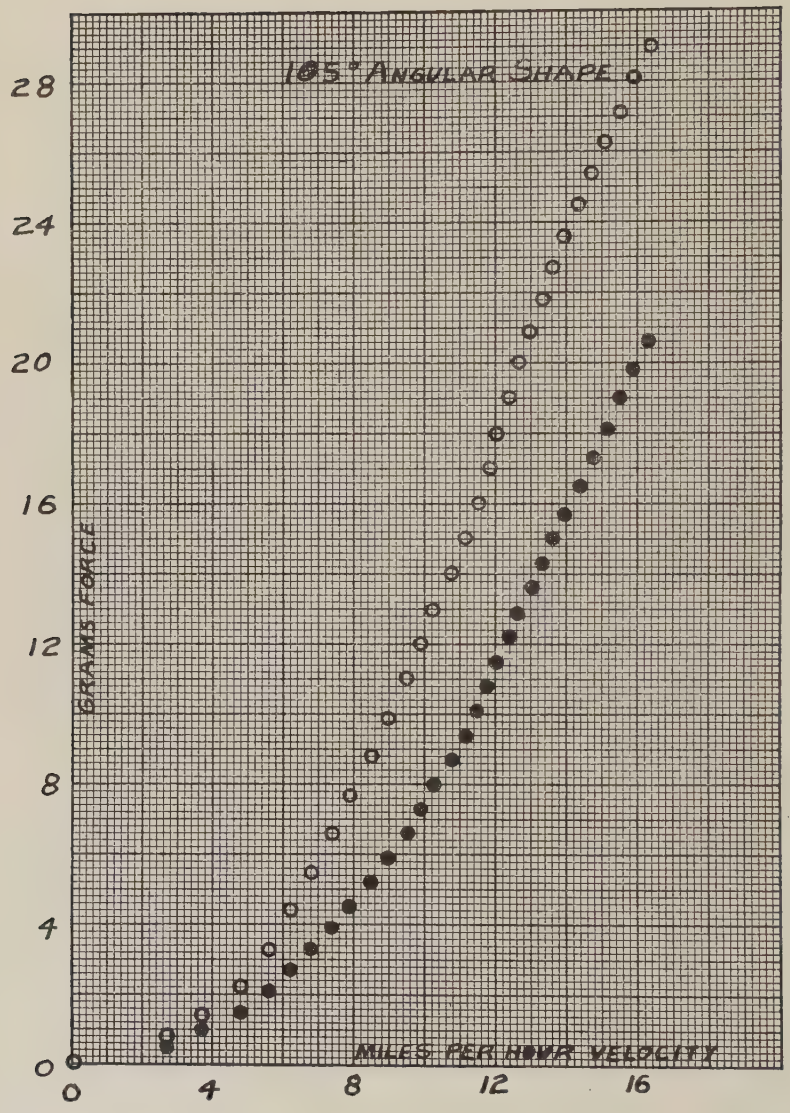

Fig. 7. Relation between force and wind velocity with 105° angular cup.

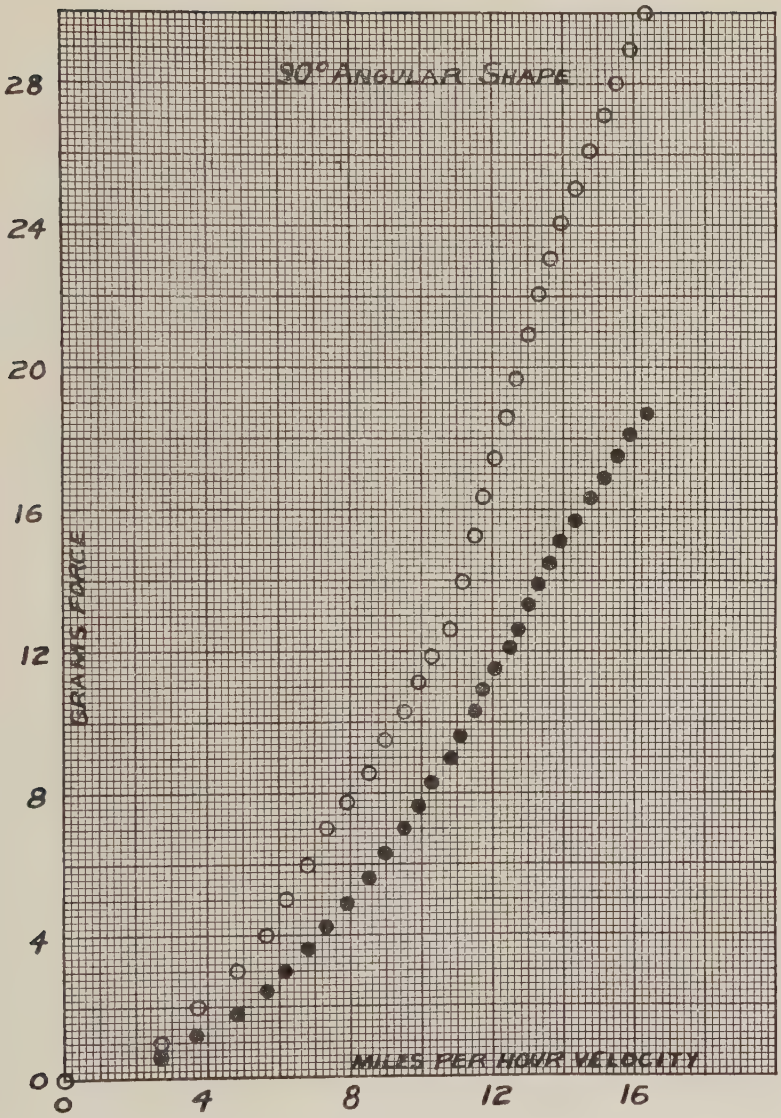

Fig. 8. Relation between force and wind velocity with 90° angular cup.

SUMMARY

From the results obtained, the conclusions of this investigation may, therefore, be summarized as follows:

(1) The ellipsoidal shaped cup is the most sensitive over the entire range tested.

(2) The conical shaped cup is fairly sensitive in both the lower and middle regions.

(3) The hemispherically shaped cup is fairly sensitive over the entire range, being only slightly less sensitive than the ellipsoidal shaped cup.

(4) The 105° angular shaped cup is very sensitive in the lowest region and fairly sensitive in the middle region.

(5) The 90° angular shaped cup is fairly sensitive over the entire region.

The entire procedure was then repeated with beaded cups. These cups were identical with those previously described with the addition of a slight beading along the outer edges. The results obtained from the testing of these shapes shows that the sensitivity of an anemometer cup is not improved by adding a bead to the cup.

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BUTOMUS UMBELLATUS IN AMERICA*

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Put-in-Bay, Ohio

During the summer of 1939 I discovered *Butomus umbellatus* growing as a very abundant plant along the gravelly or marshy shores of most of the larger islands in the western end of Lake Erie. This handsome and interesting plant is not treated in the 7th edition of Gray's Manual and its occurrence here in such abundance led me to investigate the literature dealing with its distribution in America.

This plant, commonly called in France "Jonc fleuri," is classified by some botanists in the Alismaceae but on account of its nine stamens and usually six carpels is treated as a separate family by Gaston Bonmer in his "Flora Complete de la France." It is indigenous in Europe in marshes and along borders of streams and lakes from Italy northward to Norway. According to Dr. Leo H. Grindon it is one of the handsomest plants that England produces.[1] Thomé gives a good colored plate in his "Flora von Deutschland," vol. 1, page 84 (1886).

According to Fr. Marie-Victorin,[2] "elle parait avoir été observée pour la premiere fois à Laprairie,[3] vers 1897, par le F. Euphrosin." So far as is known, the first specimens were collected in 1905, at Laprairie on the flats ("battures") of the St. Lawrence River by Bros. Marie-Victorin and Rolland-Germain.[4] A specimen in the Britton Herbarium at the New York Botanical Garden was collected September 16, 1906, by Fr. Louis Arséne on the borders of the St. Lawrence River, where he says it was common from Caughnauaga to Sorel, near Montreal.

An appearance along the canal at Ottawa as early as 1906 was reported by E. H. Blackader.[5] The same year it was found at Beauharnois, Valois, and Longueuil and in 1907 at Chateau-

*Contribution No. 19 from the Herbarium of West Virginia University.

[1]Fletcher, "Two newly introduced European plants". *Ottawa Naturalist* 22: 80, 81, 1908.

[2]"Flore Laurentienne" (1935), p. 618, footnote.

[3]Opposite Montreal.

[4]Fletcher, loc. cit.

[5]*Ottawa Naturalist*, December, 1908.

guay by L'Abbé V.-A. Huard, who recognized it at sight, presumably from his acquaintance with it in Europe.[6]

In 1908 Fletcher[7] reported that Fr. Marie-Victorin believed that it also grew around the Boucherville Islands a few miles above Longueuil. It seemed certain (he said) that it ripened its seeds at Longueuil, in spite of the late date at which the water recedes from the river flats, preventing its appearance above the surface until late in June. It was found associated with *Scirpus americanus*, *Zizania aquatica*, *Potentilla anserina*, *Mentha canadensis*, *Xanthium canadense*, *Lycopus virginicus*, *Sagittaria variabilis*, etc.

Nash, in 1909, in "North American Flora," said it was "introduced along the shore of the St. Lawrence, near Montreal, Quebec" (Vol. 17, p. 63).

In 1913 it was still so uncommon that Britton and Brown, in the second edition of the "Illustrated Flora," dismissed it summarily by the following note, inserted immediately after their treatment of the Alismaceae: "*Butomus umbellatus* L., a plant of the related family Butomaceae, with many-ovuled ovaries, rose-colored flowers and narrow ensiform leaves, a native of Europe and Asia, has been found on the shores of the St. Lawrence River, near Montreal."[8]

In 1918 Fr. Marie-Victorin reported that it covered "broad flats at least from Chateauguay to Nicolet" and was "especially abundant about Montreal." That it spreads rapidly, he says, "is shown by its conquest of this large domain in less than forty years. It has not been reported elsewhere in America."[9]

In 1922 specimens were collected on a wet stony beach at Lachine by Judge J. R. Churchill and in the "zone intercotidale de la grève de Beauport," near Quebec, by Fr. Rolland. Their collections are preserved in the Gray Herbarium of Harvard University.

The thrill that has by now been experienced by many American botanists upon the discovery of *Butomus* was ably described by Knowlton in 1923: "While collecting plants along the St. Lawrence River at Ste. Angèle de Laval, opposite Three Rivers, Quebec, the last day of July, Mr. Edward B. Chamberlin and I were much surprised to find in the swampy

[6] "Addition à la flore d'Amerique," *Le Naturaliste Canadien*, 35: 65–67, May, 1908.

[7] Fletcher, loc. cit.

[8] Vol. 1, p. 104.

[9] *Revue Trimestrielle Canadienne* 263, November, 1918.

land near the shore a striking endogenous plant that neither of us had seen nor heard of before. Good specimens were a meter tall, with an umbel of large pink flowers, veined with darker red. . . . We soon discovered that the plant did not fit the ordinary key to the endogens, for the flower had three colored sepals, three larger petals, *nine* stamens, and six *separate* carpels."[10] Knowlton reported also finding it at Pointe du Lac, Berthierville, St. Sulpice, and Ste. Lambert.

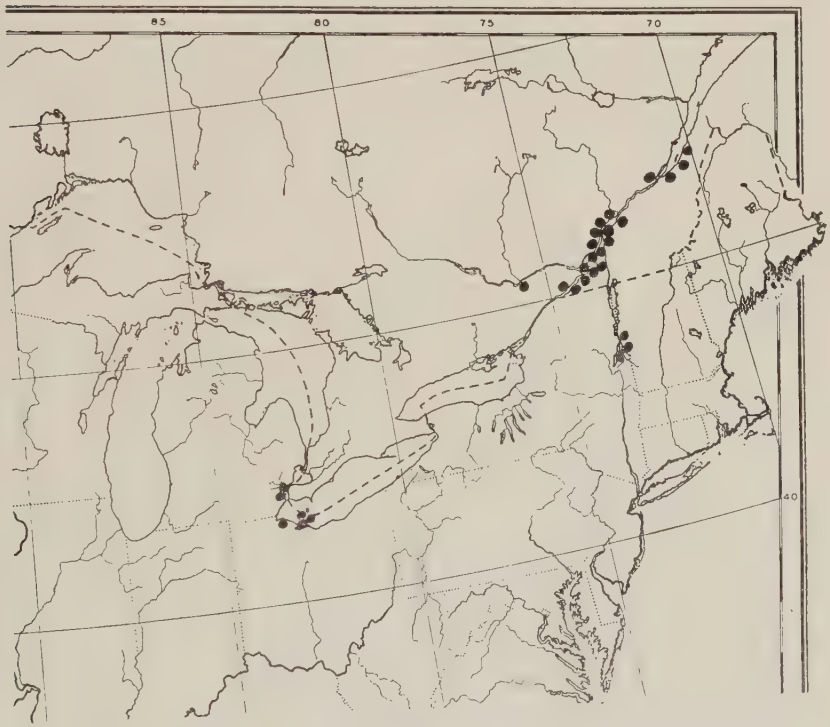

Fig. 1. Map showing recorded distribution of *Butomus umbellatus* in America.

The remarkable manner in which this introduced species has taken its place, ecologically, in the flats along the St. Lawrence is discussed by Fr. Marie-Victorin in 1929: "Le Butome, . . . l'une des dernieres acquisitions de la flore du Quebec, en moins de quarante ans a conquis les grèves du Saint-Laurent, depuis le lac Saint-Louis jusqu'aux abords de la ville de Quebec, et l'espèce est particulièrement enva-

[10] "*Butomus umbellatus* on the St. Lawrence River," *Rhodora* 25: 220, 221. 1923.

hissante dans la region de Montrèal où elle semble être apparue pour la premiere fois. Avec les années, elle regnera presque seule, semble-t-il, sur nos rivages plats au moins dans certaines conditions écologiques. C'est un bel exemple du bouleversement qui peut être opéré dans une flore par une seule espèce quand elle est bien outillée et qu'elle se transporte en territoire nouveau en laissant derrière elle la horde de ses ennemis, un bel exemple de dynamisme violent dans le temps et dans l'espace."[11]

The first record of *Butomus umbellatus* for the United States was published by Knowlton, who found it on August 11, 1929, well established and flourishing on the South Bay of Lake Champlain, at Dresden, Washington County, New York, near the bridge from Whitehall.[12] Five days later, on August 16, Muenscher found it very abundant along South Bay, "on clay flats and in water up to one meter deep;" also, later in August, at Whitehall, "along the border of a mill pond and along the Champlain canal from Whitehall northwards for about ten miles to the Dresden Narrows in Lake Champlain." The first record for Vermont was reported by the same observer, who found it in "Rutland County along the shore of Lake Champlain northward to the Dresden Narrows, and in Addison County along the outlet of East Creek."[13]

The next year (1930) Farwell collected it in Wayne County, Michigan, in Brownstown Township on August 26 and at River Rouge on September 9. Farwell notes: "This species has long been naturalized in the vicinity of Detroit and southward. I am informed on good authority that it was well established before the present century and that it covered acres of marshes at River Rouge before the operations of the Ford Motor Co. in this region reclaimed the marshland and destroyed the better part of the stand. There is nothing to prove or disprove the belief that the plant was brought over by Cadillac's party more than three centuries ago and that it has been here ever since."[14] Marie-Victorin, however, doubts that *Butomus umbellatus* was in Detroit during the French regime, believing that its first introduction "took place about fifty

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[11]"La dynamisme dans la flore du Quebec," *Contrib. Lab. Bot. Montreal* 13: 83, 84. 1923.

[12]"*Butomus umbellatus* at Lake Champlain," *Rhodora* 32: 18, 19. 1930.

[13]"*Butomus umbellatus* in the Lake Champlain Basin," *Rhodora* 32: 19, 20. 1930.

[14]Papers of the Michigan Academy of Science, Arts and Letters, 23: 125. 1937 (1938).

years ago on the St. Lawrence somewhere near Montreal."[15] In a paper presented at the 6th Congress of *L'Association Canadienne-francaise pour l'avancement des Sciences*, at Trois-Rivieres, in 1938, he "discute cette hypothèse et en montre l'invraisemblance."[16]

Writing in 1932, Fernald listed *Butomus umbellatus* as one of the characteristic plants of the St. Lawrence estuary.[17]

In Marie-Victorin's "Flore Laurentienne," published in 1935, in a chapter on "Facteurs Dynamiques Extrinseques" there is a map, "Carte R," showing the "Extension du *Butomus umbellatus* sur le Saint-Laurent, a la fin de l'année 1933." On page 618 of that work there is a description of the plant and a footnote states: "Jusqu'aux present, le Butome a conquis les rivages du Saint-Laurent depuis le lac Saint-François jusqu'a l'eau salée (St. Jean-Port-Joli). Il remonte aussi les affluents: Richelieu, Nicolet, St. François. Le Butome s'avance en eau profonde sous une forme sterile à longues feuilles dont les extremites deviennent flottantes à la fin de la saison; cette forme d'eau, f. vallisneriifolius (Sagorski) Glück, est un obstacle serieux à la petite navigation d'agrement, dans la region montrealaise. La rapidité de cette conquête s'explique par l'abondance des graines, multiplication vegetative un moyen des rhizomes tracants et des bulbilles et par l'action de la glace qui enroue les rhizomes superficiels et les transporte au loin au moment de la debâcle."

In a discussion of some phytogeographical problems of eastern Canada, in 1938, Marie-Victorin relates the story of its introduction: "Then appeared, nobody knows how, a short time before 1900 probably, a hardy and beautiful Alismaceous plant, *Butomus umbellatus*, the Old World flowering rush. Spreading very rapidly by means of its seeds, rootstocks, and bulblets, it has refreshed the rather dull purple of *Lythrum Salicaria* and painted anew the shoals with the mass effect of multitudinous pink umbels."[18] Illustrations accompanying his article show pure stands of the plant growing on shoals of the St. Lawrence, and a close-up of the rootstock, "bearing

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[15]Letter to the author, January 2, 1940.

[16]"Le *Butomus umbellatus* etait-il dèjá en Amérique au XVIIe siecle?" An abstract of the paper appears in the proceedings of the Congress.

[17]"*Callitriche stagnalis* on the lower St. Lawrence," *Rhodora* 34: 39. 1932.

[18]"Phytogeographical problems of eastern Canada," *Amer. Midl. Nat.* 19: 489–558. 1938. See especially pages 555–557.

numerous pea-size bulblets," which "powerful means of dispersal partly accounts for" its rapid conquest of the region.

The first collection of *Butomus* in Ohio was made by Louis W. Campbell at Little Cedar Point, Jerusalem Township, Lucas County.[19] Two additional Ohio counties, Ottawa and Erie, were recorded by the author in 1939.

Butomus umbellatus forma *vallisneriifolius* (Sagorski) Gluck, a sterile deep-water form with long leaves the ends of which float on the surface, was collected at Longueuil on September 12, 1931, by Marie-Victorin and Rolland-Germain,[20] and occurs elsewhere.

In addition, it should be noted that *Butomus* has been extensively introduced in numerous lake regions, particularly in New York, and may be expected to be encountered as a thoroughly established plant over a rapidly widening area. As far south as Morgantown, W. Va., it grows and flowers abundantly in the garden of Dr. H. A. Davis.

A good brief description and a sketch appear in Fassett's "Manual of Aquatic Plants,"[21] published in 1940.

The present known distribution of this species in North America, excluding the areas in which it is known to have been planted, may now be summarized as follows:

Quebec: L'Islet Co.: St. Roch-des-Aubrets, *Marie-Victorin* et al 43059, July 26, 1935. Montmagny Co.: Cap St. Ignace, *Marie-Victorin* et al 33195, July 15, 1930. Bellechase Co.: Anse St. Vallier, *Fernald* 2507, September 15, 1931. Quebec Co.: Beauport, *Rolland-Germain* 16028, August 8, 1922. St. Maurice Co.: Trois Rivières, *Stanislas;* Pointe du Lac, *Knowlton and Chamberlain*, August 2, 1923. Nicolet Co.: Ste. Angele-de-Laval, *Knowlton and Chamberlain*, July 31, 1923. Berthier Co.: Berthier, *Bonin* 261, June 26, 1931. Richelieu Co.: Ile aux Corbeaux, *Marie-Victorin* 16029, August 22, 1922. Tamaska Co.: *Adrien* 1215, July 17, 1926. L'Assomption Co.: St. Sulpice, *Boivin* 200, August 24, 1935. Chambly Co.: Longueuil, *Marie-Victorin* and *Rolland-Germain* 43815, October 5, 1934. Laprairie Co.: Laprairie, *Marie-Victorin* and *Rolland-Germain*, in 1905; La Tortu, *Fernald* 2507, September 19, 1931. Montreal

[19]In Schaffner's "Additions to the Revised Catalog of Ohio vascular plants. I." *Ohio Journ. Sci.* 33: 288. 1933.

[20]Memoires et Compte rendus de la Societe Royale du Canada III. 28: 1–17. 1934.

[21]Pages 93, 96.

Co.: Ile-Ste.-Hélène, *Boivin* 178a, August 18, 1935. Jacques-Cartier Co.: Lachine, *Churchill*, in 1922; Valois, *Huard*, in 1906. Chateauguay Co.: Chateauguay, *Huard*, in 1907. Beauharnois Co.: Beauharnois, *Huard*, in 1906.

ONTARIO: Glengarry Co.: Rivière Raisin, *Marie-Victorin, Rolland-Germain*, and *E. Jacques* 46741, August 9, 1932. Russell and Carleton Cos.: Environs of Ottawa, *Blackader* in 1906; *Rolland-Germain* 16027, June 27, 1921.

VERMONT: Rutland Co.: Dresden Narrows, *Muenscher*, in August, 1929. Addison Co.: East Creek, *Muenscher*, in August, 1929.

NEW YORK: Washington Co.: Dresden, *Knowlton*, August 11, 1929; South Bay, *Muenscher*, August 16, 1929; Whitehall, *Muenscher*, August, 1929.

MICHIGAN: Wayne Co.: Brownstown Township, *Farwell* 8742, August 26, 1930; River Rouge, *Farwell* 8759, September 9, 1930.

OHIO: Lucas Co.: Little Cedar Point, *Campbell*. Ottawa Co.: Gibraltar Island, *Core* 7098, June 21, 1939; North Bass Island, *Core* 7300, July 6, 1939; Sugar Island, *Core*, July 25, 1939; Middle Bass Island, *Core*, August 16, 1939; South Bass Island, *Core*, August 24, 1939. Erie Co.: Kelley's Island, *Core*, July 13, 1939.

For assistance in the collection of the data presented in this paper, I am indebted to Harold N. Moldenke, of the New York Botanical Garden; M. L. Fernald, of the Gray Herbarium; W. C. Muenscher, of Cornell University; Oliver A. Farwell, of Lake Linden, Mich.; and especially to Fr. Marie-Victorin, of the University of Montreal, who provided numerous details concerning the distribution of *Butomus* in the St. Lawrence valley.

A NEW GENUS (KNULLANA) AND TWO NEW SPECIES OF LEAFHOPPERS (HOMOPTERA-CICADELLIDAE) FROM MEXICO

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Ohio State University

In 1900 Dr. Ball described from a single male specimen collected in Mexico a species which he named *Thamnotettix perexigua*. Recent collecting in Mexico and the southwestern United States has brought to the author many specimens of this group which represent three distinct species. Also the present study has indicated that these do not belong to a previously described genus. The genus and two species belonging to it are therefore described and the characters of the males of the three known species are offered for their separation.

Genus **Knullana** nov.

Related to *Chlorotettix*, *Cyperanus* and *Elymanus*. Male plates with long tapering filamentous apices as in *Osbornellus*. In general form and appearance most closely resembling the larger green species of *Chlorotettix*, with banded markings on the vertex. The vertex is short and broad and bluntly angled with front. The pronotum is broader than the head. The elytra are long and narrow, venation similar to that of *Cyperanus*. Genotype *Thamnotettix perexigua* Ball.

I take pleasure in dedicating this genus to Professor J. N. Knull, who has collected so many interesting Cicadellidae in North America, especially in the southwestern United States.

Knullana perexigua (Ball)

Thamnotettix perexigua Ball. Can. Ent. 32: 339, 1900

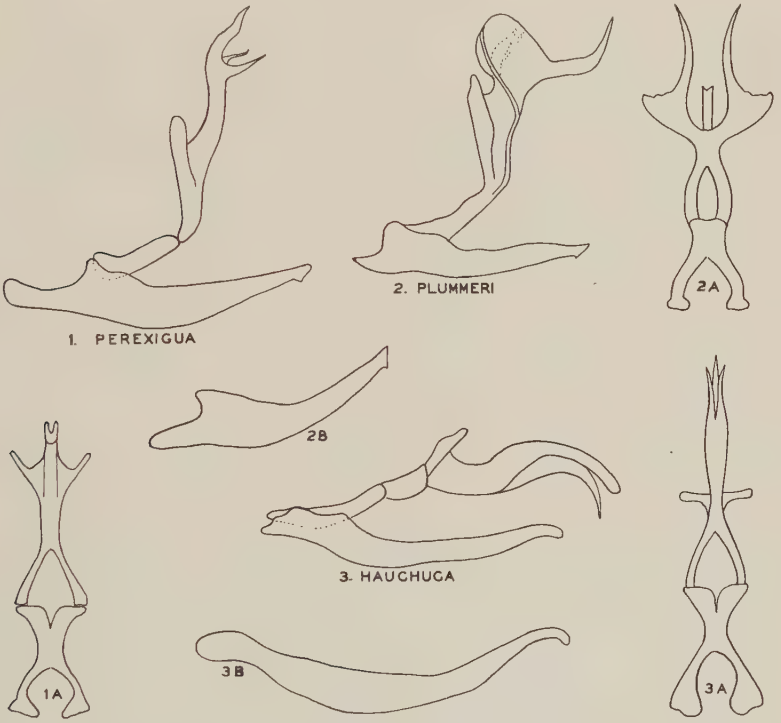
A large yellowish-green species with a black waved line above margin of vertex. Length, 8–8.5 mm.

Vertex broad, slightly longer on middle than next the eyes and more than twice as broad as long.

Color.—Yellowish-green, vertex with a black waved line above margin of vertex and a more narrow parallel line just beneath margin, forming a pale marginal band which is the width of the ocelli. Elytra greenish-yellow subhyaline, veins pale, inconspicuous. Face pale fuscous with portions of several arcs.

Genitalia.—Female last ventral segment slightly produced with a pair of long slender tapered processes arising on middle half and produced more than the length of the segment. These are separated by a deep

U-shaped notch the width of the ovipositor. Male plates long with tapered attenuate apices. Style long and rather narrow, tapered to form a rather blunt apex which bears a small tooth on inner margin. Aedeagus bifid at base with a short erect produced process at about half its length. Apex terminating in three processes, a central dorsally curved heavier portion and a ventral lateral process on either side.



1. Lateral view of style and aedeagus of *K. perexigua.*
   1a—Ventral view of aedeagus.
2. Lateral view of style and aedeagus of *K. plummeri.*
   2a—Ventral view of aedeagus; 2b—Ventral view of style.
3. Lateral view of style and aedeagus of *K. hauchuca.*
   3a—Ventral view of aedeagus; 3b—Ventral view of style.

This species was described by Ball from a single male specimen from Cuernevaca, Mexico. The allotype female is from Chilpancingo, Mexico, September 10, 1940, collected by the author.

A large series of specimens are at hand including material from Taxco, Chilpancingo, Iguala, Cuernavaca and Jiutepec, Mexico.

Knullana hauchuca n. sp.

Resembling *perexigua* in form and general appearance but smaller and darker in color. Male genitalia distinct. Length, 7–7.5 mm.

Vertex broadly rounded, more than twice as wide between eyes as median length.

Color.—Dull sordid green to greenish gray. Vertex with a broad waved black band just above margin and a similar broad waved band just below the margin. The pale marginal band just as wide as included ocelli. A broad tawny blotch just back of upper marginal line and between ocelli. Elytra grayish hyaline, nervures paler.

Genitalia.—Female last ventral segment with posterior margin strongly roundedly produced with a pair of long slender parallel processes at middle produced more than one-third the length of the segment, separated approximately the width of the ovipositor by a deep U-shaped notch. Male plates elongate, triangular, with long slender, tapered apices. Styles long, slender with apex curved inwardly. Aedeagus bifid at base with a curved dorsal portion bluntly rounded at apex and a pair of sharply pointed ventral processes which arise at apex.

Holotype male from Ramsey Canyon, Hauchuca Mountains, Arizona, September 17, 1935 (F. H. Parker); allotype female, Mexico City, Mexico, September 1, 1940 (DeLong); paratype male, Mexico City, Mexico, September 1, 1939 (C. C. Plummer). The latter specimens were swept from shrubs at an altitude of 9,000 feet.

Knullana plummeri n. sp.

Resembling *hauchuca* in form and appearance, but with distinct male genitalia. Length, male, 7 mm.; female, 7.5–8 mm.

Vertex broadly rounded, more than twice as wide between eyes as median length.

Color.—Dull green washed with yellow. Vertex with a black waved marginal line above and below ocelli. Anterior half of vertex tawny, posterior portion yellowish. Elytra dull greenish, veins yellow.

Genitalia.—Female last ventral segment produced, forming a pair of long slender parallel processes at apex which are separated by a U-shaped notch. Male plates long, triangular, with attenuate produced apices. Style elongate with a broad apex pointed on outer margin and with a slight inwardly produced tooth on inner margin. Aedeagus bifid at base with a short central dorsal process and a pair of broad plates from which arise on each side a long heavy spine which is curved upward at about half its length and tapered to a sharp point at apex.

Holotype male, allotype female and male and female paratypes collected at Cuernavaca (Morelos), Mexico, September 8, 1939, by C. C. Plummer and the author. These were swept from shrubs at the margin of pasture land. I take pleasure in dedicating this species to Dr. Plummer whose collecting in Mexico has revealed many interesting species of Homoptera.

STUDIES IN HUMAN INHERITANCE XX. FOUR SETS OF ALLELES TESTED FOR INCOMPLETE SEX LINKAGE

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It has long been known that in certain organisms some sex-linked genes are restricted to the X chromosome, others to the Y chromosome, while still others are found both in X and Y chromosomes, with consequent crossing over. In these organisms (e. g., certain fishes) there are thus three kinds of sex linkage: ordinary sex linkage (X chromosome factors), Y chromosome inheritance, and incomplete or partial sex linkage (factors on both X and Y).

Ordinary sex linkage and Y chromosome inheritance have long been known in man. Some thirty genes are known to be sex linked in the ordinary way, and four or five genes are known to be restricted to the Y chromosome. The latter include the genes for one type of webbed toes, icthyosis hystrix gravior, dense black hair on the entire ear, and hard round projecting skin lesions.

Koller and Darlington (1934) demonstrated that the sex chromosomes of mammals might also be expected to carry genes which occur on both X and Y with crossing over, since chiasmata occur between homologous portions of these chromosomes. The sex chromosomes therefore are constituted as follows: one portion of the X is non-homologous, carrying ordinary sex linked genes; the rest is homologous with a corresponding portion of the Y, and these homologous portions may carry genes which would be incompletely sex-linked. The Y in addition carries a non-homologous portion, which bears the Y chromosome factors passed from a father to all his sons.

With this histological observation and the knowledge of the three kinds of sex linkage in fishes, it was but a step to the conscious search for incompletely sex-linked genes in man. Haldane (1936) made such a search, using recorded pedigrees, and found evidence for the partial sex-linked nature of six genes: total colorblindness, xeradoma pigmentosum, Oguchi's disease, recessive epidermolysis bullosa, and two kinds of retinitis pigmentosa (one recessive unassociated with deafness, the other dominant).

Incompletely sex-linked genes will behave as ordinary autosomal factors in pedigrees except for one thing: some sibships tend to yield too many affected males and normal females, while other sibships yield too many normal males and affected females. In the case of a dominant gene, the affected offspring of affected fathers will tend to be of the same sex as the paternal parent from whom the father received the gene. In the case of a recessive gene the situation is not so obvious, and the requisite statistical analysis is rather intricate.

Thus the partial sex-linked nature of a gene may easily be overlooked in the ordinary analysis of pedigrees. Older known genes must be reanalysed for the possibility of incomplete sex linkage, and all new genes as they are discovered must be subjected to such analysis. Since the gene frequency is usually low for mutant factors in man, crossing over can not be studied between any two genes, and the investigation must concern itself with crossing over between the gene and sex, or, more exactly, between the gene and the unpaired non-homologous portion of the X and Y chromosomes.

In the absence of three-generation pedigrees, incomplete sex linkage may be investigated in paired sib material, using 2 x 2 tables such as were suggested by Penrose (1935) for autosomal linkage. Having on hand in our laboratory the records of a number of paired sibs tested for blood group, blood type, taste deficiency to phenyl-thio-carbamide and taste deficiency to mercapto-benzo-selenazol, we have set up these data in contingency tables, using the character as one variable and sex as the other. (A paper on the autosomal recessive nature of the taste deficiency to mercapto-benzo-selenazol is now being prepared for publication.)

Chi square was determined by the formula

$$\chi^2 = \frac{n\,[\,(ad) - (bc)\,]^2}{(a + b)\,(c + d)\,(a + c)\,(b + d)}$$

where a = number of pairs alike in both characters,
b = number of pairs alike in one, unlike in the other,
c = number of pairs unlike in the one, alike in the other,
d = number of pairs unlike in both characters,
n = total number of pairs of sibs.

Tables I to VI, inclusive, present the data in the form of 2 by 2 contingency tests, with the chi square determinations, and the appropriate probabilities with one degree of freedom. It will be seen that in no case is there a significant deviation from proportionality. It can therefore be stated that the genes for the blood groups, the blood types, the taste deficiency to phenyl-thio-carbamide and the taste deficiency to mercapto-benzo-selenazol do not appear to be located on the homologous portions of the sex chromosomes. We are testing this possibility for other factors in man as rapidly as possible.

TABLE I

	Sex		
	Like	Unlike	
Agglutinogen A — Like	84	52	136
Agglutinogen A — Unlike	37	17	54
	121	69	190

$\chi^2 = .076$ P = .95 — .70

TABLE II

	Sex		
	Like	Unlike	
Agglutinogen B — Like	104	62	166
Agglutinogen B — Unlike	17	7	24
	121	69	190

$\chi^2 = .061$ P = .95 — .70

TABLE III

	Sex		
	Like	Unlike	
Agglutinogen M — Like	94	55	149
Agglutinogen M — Unlike	22	9	31
	116	64	180

$\chi^2 = .070$ P = .95 — .70

TABLE IV

	Sex		
	Like	Unlike	
Agglutinogen N..... Like	83	38	121
Unlike	33	26	59
	116	64	180

$\chi^2 = 2.78$ P = .30 — .05

TABLE V

	Sex		
	Like	Unlike	
Taste P. T. C..... Like	93	63	156
Unlike	42	29	71
	135	92	227

$\chi^2 = .004$ P = .99

TABLE VI

	Sex		
	Like	Unlike	
Taste M. B. S..... Like	49	44	93
Unlike	10	15	25
	59	59	118

$\chi^2 = 1.269$ P = .30 — .05

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THE DISTRIBUTION OF CAMBARUS SLOANI BUNDY, IN OHIO[1]

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The suggestion that *Cambarus sloani* might be found in southwestern Ohio was made in a letter from Dr. Edwin P. Creaser in 1937. Acting upon his suggestion, I began to look for this species and in September, 1938, *C. sloani* was taken in Shakers Creek, Warren County, Ohio. Further collecting westward and across the Great Miami proved the species to be common and often dominant in six counties.

SUMMARY OF DISTRIBUTION

C. sloani, now recorded for the first time from Ohio, is found in the southwestern corner of the state, west of the Great Miami and the Stillwater rivers, and south of the tributaries of Greenville Creek. The species has successfully crossed the Great Miami River in Warren and Hamilton counties and now occupies a few tributary streams to the east (Fig. 7). At the mouth of Clear Creek, Warren County, only a half mile east of the Great Miami, two specimens were taken with fifty *C. rusticus*. A small percentage of the crayfish populations in Taylors and Jordan creeks, Hamilton County, is composed of *C. sloani*. It was taken once in the Stillwater River system (two specimens in Dry Run, Madison Township, Montgomery County), but was not collected in Greenville Creek or its tributaries.

C. sloani has probably invaded Ohio from the Whitewater River system in Indiana, presumably in Darke and Preble counties where the headwaters of Seven Mile and Prices creeks closely approach the Whitewater system in the flat land;

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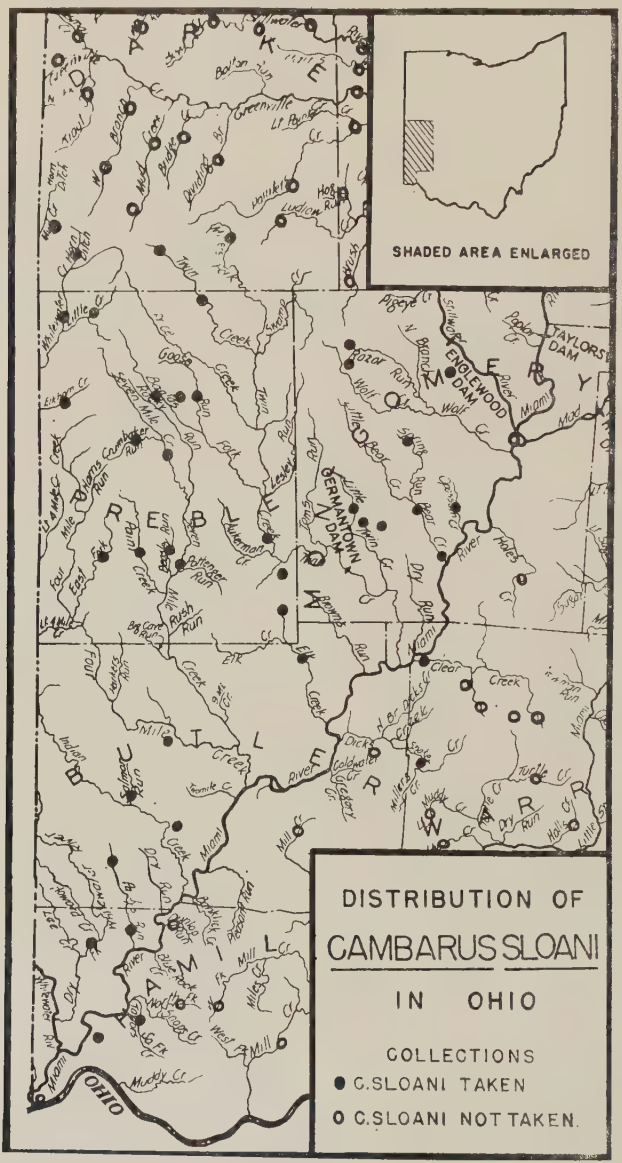
[1]This paper was prepared under the direction of Dr. R. C. Osburn, Department of Zoology and Entomology, Ohio State University, and with the co-operation of the Division of Conservation and Natural Resources.

[2]Acknowledgment is due Dr. Fenner A. Chace, Jr., Assistant Curator of Marine Invertebrates, Museum of Comparative Zoology, who furnished identified material of this species for comparison: New Albany, Indiana. (Bundy, type locality.)

I am indebted to Mr. Milton B. Trautman, Research Biologist, Ohio Division of Conservation and Natural Resources, who has so graciously found time among his own studies to assist and advise.

once the swamp forest of those counties. Seven Mile and Twin creeks contain the greatest concentration of this species



in Ohio. Curiously, none were found in Indian and Four Mile creeks, except in a few small tributaries.

No specimens have been taken from the Great Miami River itself. This river seems to be an unfavorable ecological system, even to the extent of retarding the spread of the species eastward. In recent years pollution may have become a barrier.

A specimen was taken in Shakers Creek, Warren County, a locality near the old Lebanon Canal bed. In this vicinity the Great Miami and the Little Miami drainage areas were connected from 1835 to 1865 by "Old Shakers Pond." *C. sloani* has not been taken in the Little Miami River drainage area. However, Little Muddy Creek would seem the most probable locality.

The species is known from Southern Indiana and recorded from "northern Kentucky" by Bundy. The distribution of *C. sloani* has not been well studied in Indiana. In that state it is known from the Whitewater, the White, the Muscatatuck, and the Blue rivers, all streams of southern and eastern Indiana. From the type locality at New Albany, Floyd County, Indiana, Dr. J. Sloan reports that this species is a burrower in banks of streams (Faxon, '85: 90). No burrowing habit has been observed in southwestern Ohio, except that shallow pockets have been cleaned out under flat stones.

Streams inhabited by *C. sloani* generally have a flat stone bottom. The stones are broken and well rounded by the action of the water. A lack of such stones may explain the absence of the species in Indian and Four Mile creeks, which also lack the stability of bank and bottom present in Twin Creek and Seven Mile Creek. *C. sloani* is most often found near algal beds and aquatic vegetation, and in aquaria the species consumes large quantities of plant material. Temperature does not seem to be an important factor in its distribution.

TAXONOMIC REMARKS

C. sloani belongs to the *Cambarus limosus* group, probably the most primitive division of the subgenus *Faxonius*. The male of this group is characterized by short thick gonopods, which are split for only a short distance from the tip. The annulus ventralis of the female is little sculptured and usually low and flat.

Characters.—Rostrum long with straight, slightly converging sides; excavation moderate with margins not thickened. Sides of acumen concave, forming, with the sides of the rostrum, sharp angles or small horny tips; rarely spines in adult. Spines normal in juvenile specimens. Broad, short median carina in rostrum. Postorbital ridges prominent but ends never spiniform. Cervical groove slightly sinuate and broken

above the more or less developed acute lateral spines. Areola wide (3 to 5 rows of dots). Carapace subquadrangular with no unusual granulations, but many closely set large dots (Fig. 2).

Antennal scale long, and broadest at or above the middle; medial margin uniformly curved. Epistoma broadly triangular with the two free edges elevated, elevation at the anterior tip bearing a small emargination.

Chelae with outer margin of hand keeled. Keel often divided by a closely set row of dots, forming almost a solid line down the margin. Two well developed rows of depressed tubercles on the inner margin of the palm, and usually a few irregular tubercles appear above these in old individuals. The medial margin of the movable finger also bears two rows of the same type of rounded tubercles, which diminish in size toward the distal end of the finger.

Form I.—Copulatory appendages of first abdominal segment short and thick, reaching to the coxopodite of the second or third walking leg. Hay ('95: 495) describes the rami with the outer tip turning out and the inner tip turning in. This is found to be true from a ventral aspect, that is, the outer tip curves laterally and the inner tip curves medially, but from side view the outer tip is straight and the inner tip is curved strongly outward. Outer ramus twice as thick as inner one and straight or only slightly recurved from lateral view. Body of appendage heaviest at or below the middle. Tufts of hair found on the base of the internal surface of the inner ramus and on the medio-ventral ridge near the basal articulation (Figs. 4 and 6).

Form II.—Copulatory appendages slightly shorter than Form I, and lacking the horny tip on the outer ramus. Instead, this part is bluntly rounded at the tip and has a uniform diameter throughout the distal half, which is increased twice in the basal portion. Internal ramus thicker and more closely joined to the external portion. The long gentle curvature of the inner ramus in Form II contrasts with the strong curvature near the tip in Form I. Thickest part of appendage at or above the middle. Tufts of hair ventrally and near the base may or may not be present (Figs. 1 and 3).

The annulus ventralis of the female as figured and described by Hay ('95: 496) seems to be inadequate for Ohio specimens. He does not mention the prominent diverging ridges along the anterior border nor does he refer to the deep furrows which they overhang. The elevated posterior border is a common character in the Ohio and Indiana specimens, but the tuberculation on the posterior rim amounts to no more than a general high area, as shown by my specimens (Fig. 5). This

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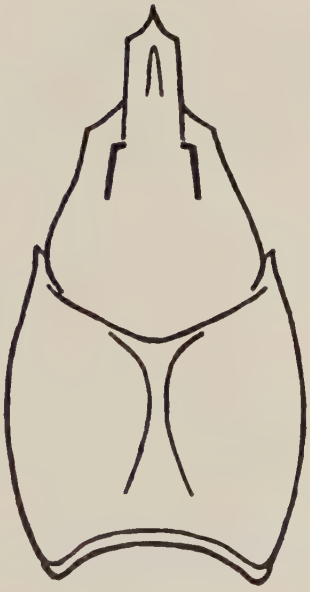
EXPLANATION OF PLATE

Cambarus sloani

Fig. 1. Gonopod, Male II, outer view.
Fig. 2. Carapace, dorsal view.
Fig. 3. Gonopod, Male II, inner view.
Fig. 4. Gonopod, Male I, outer view.
Fig. 5. Annulus ventralis
Fig. 6. Gonopod, Male I, inner view.
Fig. 7. Distribution of *Cambarus sloani.*

Cambarus sloani
Rendell Rhoades

1



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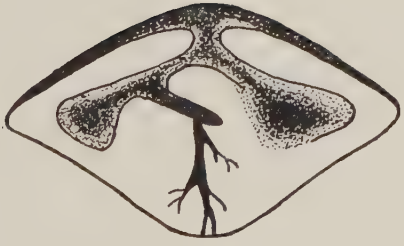

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6

posterior area is often cut by a deep medial furrow which extends anteriorly and bends to the observer's left, and is the posterior border of a prominent tubercle near the middle of the depressed area. The anterior border, nicely described by Bundy and Hay, is depressed below the sternal plates, which slope strongly downward to join the annulus.

Bundy ('76: 24) states that the "first abdominal legs short, bifid, outer part slightly longer, flattened, bent outward at apex, slightly recurved, acute; tubercles at inner base small." This describes Form I, especially from ventral view. He states that the third maxillipeds are smooth below, hairy within.

The basal segment of the telson is bispinous, according to his description, but this is not a specific character since many other species possess such spines.

Hay ('95: 496) describes the copulatory appendages as having "large inwardly projecting knobs at the base of the appendages." This projection, as Bundy states, is smaller in Form II than in Form I. The appendages in Form II often lack any basal articulation and are thus easily lost.

COLORATION OF CAMBRIUS SLOANI

The color resembles somewhat the members of the *propinquus* group. The green pigment, so prevalent in the *rusticus* group, is lacking. The coloration of the carapace is in shades of brown. The darkest color is found immediately in front of the cervical groove, and on the dorsolateral portion of the posterior branchial regions. The middle of the areola often bears a dark stripe of brown. Within the concavity of the rostrum is always found light and dark brown in various patterns.

The abdomen of old individuals is marked with two irregular lines of dark pigment down the dorsum; in young specimens these may appear as a dark spot on each segment. The posterior margin of each segment is marked with a thin line of orange, extending over the tergum from one pleural lobe to the other.

The chelae are light flecked with dark, which at first sight, gives them the appearance of having coarse tuberculation. The tubercles on the dorsal anterior articulation of the carpus, the dorsal articulation of the movable finger, and the tips of both fingers are bright orange. Immediately behind the orange tips of the fingers are brownish, almost black bands.

The ventral portions of the body of clean individuals are nearly white, much lighter than any of the *rusticus* or *propinquus* group.

COPULATION RECORD

Oppossum Run, Sec. 23, Jefferson Twp., Montgomery Co., Ohio. October 10, 1938.

REFERENCES

Bundy, W. F. 1876. Bull. Ill. Mus. Nat. Hist., 1: 24.
1877. Proc. Acad. Nat. Sci., Phila., 1877, p. 172.
Faxon, W. 1885. Mem. Mus. Comp. Zool., 10 (4): 89–90.
Hay, W. P. 1895. 20th Ann. Rept. Ind. Geol. & Nat. Resources Sur., 1895, pp. 195–6.

A SYSTEMATIC STUDY OF THE MAIN ARTERIES IN THE REGION OF THE HEART—AVES

II. (Crotophaga ani), (Saurothera merlini), and (Coccyzus americanus)

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INTRODUCTION

In a recent paper (2), the writer discussed the arrangement of the arteries in the region of the heart of three members of the Heronidae and the Belted Kingfisher (*Ceryle alcyon*). A recent shipment of birds from the West Indies made possible the study of the arrangement of these same arteries in three members of the Cuculidae. The findings are set forth in the following observations.

OBSERVATIONS

The right and left common carotid arteries arise from the innominate arteries and proceed anteriorly to the thyroid gland. At this point each vessel gives rise to (1) an internal carotid artery which passes anteriorly along the side of the neck, and (2) an external carotid artery which soon enters the hypapophysial canal. The internal carotid is superficial and smaller than the complimentary external carotid artery. The external carotids of the Cuculidae do not fuse to form a common trunk artery as in the case of the Kingfisher.

The subclavian artery sends off the axillary artery and the internal mammary artery before giving rise to the two pectoral arteries. The internal mammary arises as a branch of the coracoid artery (new artery) which supplies the muscles in the region of the coracoid bone. In general this is the condition represented in most species of Ohio birds, and is found especially common in the Passeriformes.

As in other birds, the right 4th aortic arch arises from the right innominate artery and passes posteriorly to fuse with the right radix aorta which later joins the dorsal aorta. In both Saurothera and Coccyzus, the left radix aorta is present as a ligamentous vestige, but in Crotophaga there is a small stump of the right radix aorta with a small ligamentous tip.

In the latter, the anterior projection of the ligament is entirely wanting.

A vestige of the embryonic right 6th aortic arch is present as the Ligamentum Botalli (3) in each of the three species. This ligament is located on the ventral surface of the right radix aorta and is attached anteriorly to the pulmonary artery. The extent of this ligament varies slightly, and is most prominent in Crotophaga, somewhat reduced in Saurothera, and almost imperceptible in *Coccyzus americanus*. With reduction of the left radix aorta, the left 6th arch becomes completely absorbed and cannot be traced in the adult specimens.

CONCLUSIONS

It may be concluded that the Cuculidae show considerable similarity in the basic arrangement of the main arteries in the region of the heart. This similarity within the family may aid in the superordination of the families in the order.

Since the Kingfisher (*Cerlye alcyon*) (1 and 2) shows a more primitive condition than that found in the Cuculidae, it may be regarded by some as more primitive, but the writer must conclude that there are several points of advancement expressed in the basic arrangement over that of the Cuculidae (2), and that the retention of the left radix aorta is to be regarded as singular and characteristic of the species.

SUMMARY

1. The main arteries in the region of the heart of three species of Cuckoos were completed. The arrangement of these vessels were strikingly similar in all species.

2. The ligamentous vestige of the left radix aorta was present in each species.

3. The right Ligamentum Botalli was present in each species, but the left vestige of the 6th arch was completely atrophied.

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(1) **Glenny, Fred H.** 1939. "An Anomalous Artery in the Kingfisher (*Ceryle alcyon*)." Columbus. The Ohio Journal of Science, 39: 94–96.

(2) **Glenny, Fred H.** 1940. "A Systematic Study of the Main Arteries in the Region of the Heart—Aves, Part I." Philadelphia, Anatomical Record, 76: 371–380.

(3) **Glenny, Fred H.** 1940. "Presence of the Ligamentum Botalli in the Golden Eagle (*Aquila chrysaëtos*) L., the Red-tailed Hawk (*Buteo borealis borealis*) Gmelin, and the common Pigeon (*Columba livia*)L." Columbus. Ohio Journal of Science, 41: 46–49.

BOOK NOTICES

The Modern Study of Botany

The "Textbook of Botany" by Transeau, Sampson, and Tiffany is not just another text, but a book full of interesting reading, a text which combines the "fundamentals" with the realities of life. One finds in it the usual material contained in most college texts, but the arrangement is new, the approach is alive. The book is remarkably well illustrated, with numerous attractive halftones and several reproductions of kodachrome pictures, as well as the usual line drawings. An examination of the 424 figures (with their legends) gives a comprehensive view of the contents.

Wherever possible, the approach is physiological or ecological, as is to be expected from these authors. The arrangement of topics is pleasing; one thing leads logically to the next. Although the essential sequence is here, the book is not conspicuously divided, as are so many texts, into a part primarily structure and physiology, followed by a part primarily morphology of the several phyla. In fact, about two-thirds of the book is devoted to carefully inter-related treatments of physiology and anatomy together with the influences of environment and heredity. For example, "the tissue system of leaves" is followed by "environment and leaf development,'. and "hereditary differences in leaves." "A bit of useful chemistry" should be really useful before embarking upon the several chapters concerned with food manufacture. A general treatment of "non-green plants" is followed by chapters on the "biology of bacteria," "bacteria of the soil," and "fungi," with a chapter on "plant diseases" in which the student discovers the role of bacteria and fungi in causing diseases of higher plants. "Under-water environments" is a pleasing prelude to the consideration of "algae." A brief but profusely illustrated chapter on the vegetation of North America gives a clear picture of the major plant formations.

It is true that this text is not adapted to the usual routine followed in many colleges, but the "routine" could be adapted to the text. The use of such a text should help to revitalize college botany.—*E. L. Braun.*

A Textbook of Botany, by E. N. Transeau, H. C. Sampson, and L. H. Tiffany. 812 pages. New York, Harper and Brothers, 1940. $4.00.

This Living World

One of the major objectives, if not the chief objective of the general course in biological science taught in many colleges, is to aid the student in acquiring a more accurate concept of living organisms and his own relation to the world of life. The paths which are followed in attempting to achieve this objective are almost as numerous as the men and women who teach such courses. No "best" procedure has yet been developed, nor probably ever shall be. Each teacher strives constantly to find a "better" plan and out of these strivings new books develop which are submitted for the approval and use of others.

Another admirable attempt at a *better way* is presented in the present volume. This book is designed for use with a companion volume, "This Physical World," in "cultural" or "exploratory" type courses. The book reads like a novel. The scene is set with a word picture of the changing concepts of life, the nature of the earth's crust, and the turbulant domain which life inhabits. From this point the plot is developed first in a general way with consideration of "living chemicals," "patterns of life," life in the seas, and life on the land. Then more particularly with reference to man; his racial development, his similarity to other vertebrates, his physiology and finally a short discussion of human culture.

Such a book is not intended for use as a text in the usual laboratory course in Zoology, but it surely could be used with profit as supplementary reading. At the end of each chapter is a list of references for more extended reading, each of which is annotated.

The mechanics of the book are excellent. The heavy black type is restful to the eye. The illustrations are superb. Many of these are Louise Waller Germann's black and white semi-diagrams resembling wood cuts. Others are actual photographs which show an expert's touch.—*Paul E. Schaefer.*

This Living World, by C. C. Clark and R. H. Hall. 519 pages. New York, McGraw-Hill Book Company, Inc. 1940. $3.25.

A New Bird Guide

This little book is intended to give the bird student a simple but adequate pocket guide for the identification of birds in the field. About half the book consists of an analytical key, and the rest of illustrations and descriptions.

The characters given in the key are for the most part adequate for field identification. The first divisions of the key are based on habitat. Although many species are keyed out in two or three of the six different habitat groupings, the student may occasionally have to look for a bird under a somewhat different habitat in the key than that in which he sees the bird. The surface-feeding ducks, for example, are keyed out in only one habitat grouping, "marshes, reeds, wet meadows," and not in "open water: lakes, ponds, streams."

The illustrations are by Roger T. Peterson, and depict 184 species in 27 line drawings, 4 colored plates, and 14 monochrome plates. They are similar to those in Peterson's "Field Guide to the Birds." The descriptions are brief and concise, and include information on the size, field markings, residential status in northern Ohio, and habitat. No attempt is made to designate or distinguish between subspecies.

The book covers the more common birds of the Lake Erie region, but will be usable for the more common birds throughout northeastern United States. It keys out 188 species (including different plumage variations) and contains descriptions of these and some 30 others. While nearly every bird which a student might see in northern Ohio is included, there are some, which are rare in northern Ohio but more common in central or southern Ohio, which are omitted. For example, the Carolina chickadee, Bewick's wren, summer tanager, prairie warbler, and a number of others are not mentioned.

This guide is pocket size and is printed on a good grade of paper and bound with a flexible binding. It should prove particularly helpful to the beginning bird student, but even experienced bird students will find it a good book to own.—*D. J. Borror.*

A Field Key to Our Common Birds, by Irene T. Rorimer. 160 pp. Cleveland Museum of Natural History, Pocket Natural History No. 8. 1940. $1.50.

Physico-Chemical Methods

Reilly and Rae

The third edition of this well known and authoritative work is presented in two volumes and the authors intend to later add a supplementary volume before bringing out a fourth edition. Volume I, *Measurement and Manipulation*, is concerned chiefly with the principal types of measurement and essential apparatus. The inclusion of a new chapter on Measures and Units written by Professor A. O'Rahilly of University College, Cork, should prove of great value to both students and teachers of Physical Chemistry laboratory courses.

Volume II, *Practical Measurements*, deals mainly with practical applications, covering such topics as separation processes, optical measurements, spectrometry, electrochemistry, indicators, hydrogen in concentration and electrolytic conductivity. Included also are new chapters on Colloids and Radioactivity together with a revised and rewritten chapter on Thermionic Vacuum tubes.

A new and worthwhile feature of the present edition is the inclusion of literature references covering each section under the heading of "Suggestions for Further Reading." While the authors have succeeded in the difficult task of preventing the work from assuming encyclopedic proportions, it does seem that some of the more elementary material could still further be curtailed or eliminated, so as to provide a more extended treatment of the advanced physical-chemical methods, all contained in a single volume.—*Wesley G. France.*

Physico-Chemical Methods: Joseph Reilly and William Norman Rae. Volume I, *Measurement and Manipulation*, 686 pp. Volume II, *Practical Measurements*, 580 pp. D. Van Nostrand Co., Inc. December, 1939. Price, $17.50.